THE

ELECTRICAL REVIEW.

VOL. XXXI. NOVEMBER 11, 1892. No. 781

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893,

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Published every FRIDAY, Price 4d.

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THE THIRSK RAILWAY ACCIDENT.

THE terrible accident which befel the Great Northern Scotch express on its up journey on the morning of the 2nd inst. will for long remain fixed on men's minds—an annal in railway accidents. Since the memorable Abergele accident nothing so terrible, nothing which has so forcibly appealed to the possibilities of railway travelling, has taken place. How it occurred we all know, and in knowing, deeply as we may lament the result, we cannot but feel some sympathy for the poor instrument by whom it was brought about. With that part of the catastrophe it is, however, not our desire to deal. The point towards which we would rather direct our mind is whether the horror which accompanied the accident—the conflagration which immediately ensued—was contributed to by the form of illuminant employed to light the train. Certain letters have recently appeared in the *Times* directing attention to the danger which would, in all probability, attend accidents to railway trains for the illumination of which compressed gas is employed. The writer of these letters would appear to have applied his pen to the task immediately after the Clapham Junction accident, which, it will probably be remembered, was the result of a collision between a passenger train and a train of empty coaches. The full train ran into the empties, the carriages of which were lighted by compressed gas, and the guard's van and the next coach were instantly in a blaze, and in a surprisingly short time were reduced to ashes. The writer then prophesied that the employment of this illuminant would sooner or later be attended with dire consequences, and he now again writes to the *Times* emphasising his former warning, and again urging the desirability of railway companies finding a less dangerous medium for lighting their carriages. The subject is one which, combined with the recent lamentable affair at Thirsk, cannot fail to elicit similar comment from individuals as well as from our contemporaries.

There can be no question that had the vehicles which were so rapidly destroyed in the Clapham Junction collision been filled with passengers, an even greater thrill of horror would have passed through the country than has now been experienced with regard to Thirsk; for, whether the burning of the portion of the train consumed by the fire was actually the result of the escaping gas or not—a point which we hope to see most thoroughly enquired into—there can be no doubt that the means for a conflagration were there. The vehicles were broken up, and in the operation it was impossible that the service pipes which conduct the gas to the lamps should not become severed. Wherever this was the case, there, we know, the gas must have come out with uncontrolled force, and it only needed a light, a spark, in its path to ignite it. Once ignited, anything combustible must have speedily succumbed to it.

It is to this point we desire to direct attention. In the employment of compressed gas we have, as was pointed out by Sir Frederick Bramwell during the discussion on Mr. Langdon's paper on "Train Lighting," an additional source of danger to railway travelling. We, ourselves, have not failed as circumstances have occurred, to comment upon the subject. Was the burning of the Scotch express due to it? Was the burning of the coaches in the Clapham Junction accident due to it? Is it a source of danger, or is it not? These are points which we commend to the careful consideration of all whom it may concern. It is, to our mind, immaterial whether the conflagration which has been on every one's mind during the past week was, or was not, the result of its presence? Our contention is that in its use there lies a source of danger, the effects of which, sooner or later, will involve us in disaster.

We are perfectly sensible that in thus expressing our opinions we are exposing ourselves to adverse criticism—that we are laying ourselves open to a charge of partiality. Of this we are fully aware, and, in the face of it, we hesitate not to reaffirm all we now say, and have said, upon the subject. It is generally agreed that in electricity, if properly fostered, railway companies may find an illuminant free from all this terrible danger—an illuminant more acceptable to the travelling public, and one which is no more costly than gas, and which, when more fully developed, and more widely applied, cannot fail to be even less costly. So far railway companies, as a rule, have done little to foster the use of the light. The Brighton Company has been the pioneer, and has held on its way, gradually increasing, year by year, the trains lighted by its means. We rejoice to hear that that company is still extending its use, that more trains are being fitted, and this to the exclusion of gas. We think that company wise in its generation, for it will probably not have to look back, at some future period, with regret at large outlays, such as several companies have incurred, and are incurring, in establishing a means of producing an illuminant which public opinion will condemn. To Mr. Houghton, their electrical engineer, the directors of the Brighton Company will owe their acknowledgments for his perseverance in saving them from such an outlay. The next—in fact, the only other—company to be noticed as seeking to fight out the question, is the Midland. The directors of that company, ever to the fore in improvements, have so fully gone into the subject in all its bearings, submitting it to all possible tests, to all of which, so far as we can learn, it has fully responded, that there ought to be little doubt of its full and thorough applicability to the purpose. We should perhaps be deemed guilty of an injustice if we did not also mention that the Great Northern Company did also make some effort to establish electric lighting on some of their trains. It was not successful, and the reason of its failure is not difficult to fathom. That company, like many others, anxious to comply with the demands of the public for a better form of light, thereon wholly and entirely committed themselves to gas. Whether it would not have been wiser for them to have followed the course pursued by the Midland, and sought to develop the electric light, is a question which we cannot but think the near future will answer.

Gas, in our opinion, is superior to electricity only in the convenience of its application. Electrically-fitted stock must be kept together—and here, in all probability, the Midland has had the greater fight, for with trains formed of stock brought together at various points of the journey, either a difficulty must have now and then arisen where additional coaches were required, or the continuity of the electrically-fitted vehicles must have been broken—but gas fitted vehicles can be interposed anywhere. Hence, no doubt, the traffic authorities, responsible for the accurate running of the trains, will largely favour gas. We venture to think, however, that the subject will, in the interest of the companies themselves, as well as that of the travelling public, have to be considered on wider ground than this. The present is a fitting opportunity, and we trust that, in the interests referred to, the question will be fully dealt with. If, in the employment of gas as an illuminant for railway travelling there lurks a danger which, even only under exceptional circumstances, must sooner or later add to the horrors of railway disasters, then, whether in electricity we have a good (from an illuminating point of view) substitute or not, let that which is dangerous be, so far as is possible, dispensed with. A good light is a luxury, but if the luxury is to be an ever-present source of danger, we had better be without it, even if we revert to the old oil lamp.

We cannot close this article without an expression of gratitude that this accident, bad as it is, was not attended with still more serious results. We have no knowledge of the number of passengers in the train, but having regard to the speed at which it was travelling, and the heavy mass with which it collided, there is reason to be thankful that the casualties to life and limb were not more numerous than they were. This is probably the result of two factors; first, that the heavy goods train had got into motion so that the impact was not with a dead mass; and, secondly, in that the heavy "Pullman" car acted as a barrier between the front and rear portion of the train. In this latter result we have matter for consideration. The use of the Pullman car has not been greatly favoured by travellers; there is a decided preference for that privacy which the car does not afford. This is doubtless a mere prejudice which may, with general advantage, be rubbed down. Vehicles with several divisions, as in our ordinary railway carriages, must necessarily, when in collision, prove more destructive to the lives of those within them than an open car with no such divisions. In the one the crash, the forcing together, means the forcing together of the partitions which go to form the separate compartments. In the other, it means the compression of the air within the long compartment. It is an object lesson in railway vehicle construction for long journey trains, to which railway companies will, no doubt, afford that attention which it appears to demand.

THE AGE-COATING IN INCANDESCENT LAMPS.

AN article bearing this title appeared a fortnight ago in a contemporary. The subject is an important one from several points of view, and we hail any contribution, like the present one, which indicates intelligent thought and careful experimental investigation. The darkening phenomenon is considered from three points of view—its colour, its distribution, and the loss of light it occasions. With regard to the first of these points, it is interesting to learn that

although the differences in colour noticeable between different classes of lamps are very slight, they can still be detected. This may, perhaps, be taken to indicate that although the deposit is to all intents and purposes pure carbon, it may yet not be absolutely pure, but may contain traces of other elements (probably hydrogen) combined with it. The fact that the degree of incandescence to which a particular type of lamp is run does not affect the colour, would tend to show that there is no influence of an exclusively physical nature at work to cause a difference, and thus the view that the chemical composition varies slightly, receives some additional support. It is quite possible that a careful enquiry by the chemist into the nature of the deposit would not succeed in throwing much light on the subject, but we think that it would be well worth the trial.

With reference to the typical lamps selected to illustrate the behaviour of the two widely-different classes of lamps, viz., those with treated and untreated filaments, only a few comparisons of any value can be made, owing to the difference in E.M.F., candle-power, and efficiency; one lamp had an initial reading of 101·8 volts, 16 C.P., 3·015 watts, the other 36 volts, 8·2 C.P., 5·16 watts. Doubtless the size of the bulbs was also different, a feature which would add yet another complication in making comparisons.

The result of the examination relating to the distribution of the film was that it is deposited in a very uniform manner. This arises from the very probable circumstance that the respective filaments were of symmetrical shape, and well centred in the bulbs. Had the filament in any lamp been appreciably inclined so as to be nearer to one side of the bulb than the other, the deposit would not have been found to be so regularly distributed. The carbon particles or molecules emitted from the filament do not fill the bulb in the manner of a gas; they turn no corners. The matter being in the radiant condition, flies direct from the filament to the glass; and if a portion of the glass is nearer to one part of the filament than another, it will receive an extra shower of obscuring particles. We are surprised that no reference is made to the slightly coloured thread of glass which follows the filament in every lamp bulb, and which is so clearly seen in well blackened lamps containing ∩-shaped filaments. This phenomenon was observed many years ago.

In respect to the loss of light occasioned by the film, we fully endorse Mr. Nichol's conclusion that it is sufficient to account for a very considerable percentage. We remember on one occasion removing the filament from a rather deeply blackened lamp, after first having taken a careful photometric reading, and then sealing it into a new bulb. On running the completed lamp at the same E.M.F. as previously, the increase of light amounted to 15 per cent. We do not feel equally convinced, however, that one of the causes of loss of light in lamps, mentioned at the commencement of the article, is due to depreciation of vacuum, excepting in an exceptional few, that are obviously leaky. Neither the test with the induction coil, nor that of letting mercury into the bulb, give any indication of loss of vacuum. Had the loss which occurs in very many lamps, due to an increased radiating surface of the filament through its becoming darker, and therefore rougher, with age, been mentioned instead of the supposed decrease in vacuum, a far more significant cause of loss of light would have been enumerated.

The concluding remarks relative to the indication that blackening occurs to a proportionately less extent as the efficiency is increased, are very interesting, both from a scientific and economic point of view.

Cataphoric Medication.

THREE papers on this subject were read before the American Electro-therapeutic Association last month. One by a medical man, Dr. Peterson, and two by electricians, Mr. A. E. Kennelly and Prof. Houston. Dr. Peterson and Mr. Kennelly each gave a historical sketch of the subject, but both of them failed to notice that any attention had been given to this new and very interesting branch of medical electricity in this country, beyond the early and uncertain experiments of Dr. B. W. Richardson, on what was at the time (1859) described as "voltaic narcotism." It should not, however, be forgotten that in 1889 Mr. Newman Lawrence and Dr. A. Harries, first separately, and later on conjointly, made public the results of investigations they had made in connection with the local administration of drugs through the skin by means of the cataphoric property of continuous currents. These results were afterwards set forth in a paper read before the Society of Arts, and showed that these investigators had been so far successful as to have adopted definite processes of electric endosmose in the treatment of disease. We believe these gentlemen were the first to suggest and adopt the term "cataphoric medication." The subject is attractive but also difficult, for the cataphoric action relied upon may be easily upset by a counteracting electrolytic action. Such solutions as are good electrolytes would manifestly be of little value for cataphoric medication. The chemical changes set up by electrolysis might so alter their condition as to render them quite unfitted for the particular action required of them upon the part under treatment. The difficulties in the way of correct measurement of the dose administered in this manner are also great, for though a definite quantity of a known solution may be placed in or upon an electrode, the quantity which reaches any part beneath the skin must remain a matter for conjecture rather than of proof. In skin diseases there must surely be the best chance of usefulness for cataphoric medication, as practically the whole of the solution passed must be concentrated upon the diseased part before it can be subject to the wider distribution consequent upon the diffusion of the current in its course through the softer and moister tissues. Dr. Peterson submitted a list of drugs specially suited to cataphoric action, but the reports we have seen do not enumerate them. Prof. Houston appears to have made a slip, which is very surprising from so well known and respected a physicist. He commences his paper with the statement that "By cataphoresis is meant the introduction of drugs as a medicine into the human body by means of the electric current." Cataphoresis was, we believe, known as a term expressing the cataphoric property of electric currents long before the idea of applying this property for the purpose of introducing drugs into the human body was thought of, and the term in itself does not imply any connection with the human body. Cataphoresis is the electric principle relied on to perform the particular work, *i.e.*, passing drugs in solution into the human body, but it is also the principle by which substances in solution may be passed through any animal membrane. The principle is wider than its special application, and it seems to us that Prof. Houston's valuable communication is considerably weakened by his failure to recognise this distinction.

RESEARCHES ON DISSOCIATION CONSTANTS.

THE electrical conductivity of acids in dilute aqueous solution has received a good deal of attention during the last few years, and its importance has been demonstrated by the theoretical and experimental work of Ostwald and Arrhenius. The latter, in 1884, pointed out the existence of a remarkable parallelism between this property of acids and their chemical affinity, as measured by any of the ordinary methods of chemical dynamics. And the proportionality of these two properties is held by some to be fully accounted for by the dissociation hypothesis.

According to the theory of electrolytic dissociation (which was first advanced to explain the phenomena of electrolytic conductivity in solutions), salts, acids, and bases, when dissolved in water, are more or less split up into electrically charged molecules or ions. Hydrogen, metals, and metallic radicles such as ammonium, are charged, according to Faraday's law, with positive electricity, whilst hydroxyl and acid radicles are similarly charged with negative electricity. Hydrogen chloride, for example, is supposed to exist in dilute solutions almost entirely as charged ions, viz.,

$$\overset{+}{\mathrm{H}} \text{ and } \overset{-}{\mathrm{Cl}};$$

the charged hydrogen atoms being independent of the charged chlorine atoms, except in so far as the electrical charges prevent the concentration by mechanical means of any one kind of atom in a particular portion of the solution.

Now acids, in aqueous solution, are supposed to act as acids solely in virtue of the hydrogen ions they produce, and the more hydrogen ions a given quantity of acid, reckoned in equivalents, will produce, the stronger is that acid. But the hydrogen ions, besides their chemical activity, have also the power of carrying electricity, and the more there are present in solution, the more electricity will be conveyed, that is, the greater will be the conductivity of the solution. In this way, it may be seen how the affinity, or strength, of an acid goes hand in hand with its electrical conductivity.

The molecular conductivity of a substance in a given solution is equal to $c\,v\,/\,r$, where r is the resistance of the solution, v the number of litres in which one gramme-molecule of the acid is contained, and c, the constant of the electrolytic apparatus. Whilst the molecular conductivity of strong acids varies little with the concentration of the solution, that of weak acids increases considerably as the concentration diminishes, varying approximately as the square root of the dilution or the number of litres in which one gramme-molecular weight of the acid is contained. Ostwald, however, by the consistent use of the theory of electrolytic dissociation and the ordinary chemical law of mass action, arrived at an expression, involving the conductivity, which is independent of the dilution at which the measurement is made.

From his investigations of the conductivity of salts and strong acids at extreme dilutions, Kohlrausch found that the molecular conductivities of these substances reach a maximum value at a certain dilution, and thereafter remain constant, although the dilution is increased. The maximum value of the molecular conductivity for each substance is composed of two terms: one depending on the positive ion, the other on the negative ion. This behaviour is accounted for on the dissociation theory in the following manner:—The conductivity of a solution depends only on the number and the speed of the ions which it contains. At a given temperature the speed in dilute solutions is constant, so that if the molecular conductivity increases with the dilution, the increase can only be on account of an increase in the number of the ions, that is, on account of the increased dissociation of the dissolved substance. When the molecular conductivity no longer increases as the dilution proceeds, but remains stationary, this is due to the dissolved substance being entirely split up into its ions, and now the maximum molecular conductivity is determined solely by the speed of the ions. The numbers found by Kohlrausch to be characteristic of each ion thus represent the velocities of the ions, and the molecular conductivity of any substance, when it is entirely dissociated, may be numerically stated as the sum of the velocity number pertaining to its ions. It is only in the case of salts and of powerful bases and acids, such as potassium hydroxide and hydrogen chloride, that values for the maximum molecular conductivity can be determined; weak acids and weak bases give values which still increase at the utmost attainable dilution. Although, therefore, the maximum molecular conductivities of weak acids cannot be directly determined, it is yet easy to assign values to them by making use of the considerations mentioned above.

The maximum molecular conductivity of the sodium salt of the weak acid may be determined directly; from this there is subtracted the number which represents the speed of the sodium ion—the remainder represents the speed of the negative ion or acid radicles. This remainder, added to the number which gives the speed of the hydrogen ion—found from observations with strong acids, such as hydrogen chloride—furnishes the molecular conductivity at infinite dilution, that is, the maximum conductivity.

Ostwald (*vide Zeit. Physikal. Chem.*, ii., p. 840) from the examination of a great number of sodium salts of various acids has been able to state certain rules connecting the composition of acid radicles and their velocities, so that it is in general unnecessary to observe directly the molecular conductivity of the sodium salt of an acid to be investigated, the speed of the negative ion being ascertainable with sufficient accuracy from its composition.

The molecular conductivity of an acid at infinite dilution being thus determined, its molecular conductivity at any other dilution can only differ from this in virtue of there being relatively fewer ions in the solution to carry the electricity, for the speed of the ions does not vary, and each ion always carries the same charge. It is thus evident that the molecular conductivity is proportional to the amount of electrolytic dissociation, and the ratio of the molecular conductivity at the dilution, v, to the molecular conductivity at infinite dilution, that is, the ratio $\frac{\mu_v}{\mu_\infty} = m$, gives at once the degree of dissociation or proportion of the whole dissolved substance which is dissociated.

Now, according to the general law of mass-action, the product of the active masses of the dissociated ions must be proportional to the active mass of the undissociated acid. Suppose the volume in which one gramme-molecule of a monobasic acid is contained, to be v, then the mass of the acid in this volume is represented by 1. Of this the proportion dissociated is m, and the proportion undissociated, $1 - m$. The active mass of each product of dissociation is $m\,/\,v$, and of the undissociated acid, $(1 - m)\,/\,v$. Therefore, according to the principle of mass-action above referred to,

$$\frac{m}{v} \cdot \frac{m}{v} = \mathrm{K}\,\frac{1 - m}{v},$$

where K is a constant, or

$$\frac{m^2}{(1 - m)\,v} = \mathrm{K}.$$

The constant, K, is the dissociation or affinity constant of Ostwald, and is, for any one acid, independent of the dilution. It represents, numerically, the reciprocal of twice the dilution at which the acid is half dissociated. As its value in the units adopted is inconveniently small, a constant, K, ·100 greater, is usually chosen as the affinity constant.

Ostwald (*Zeit. Physikal Chem.*, iii., p. 170, p. 241 and p. 369) determined this constant for over 240 acids, and since his fundamental research other investigators have been at work on the same subject. The principal papers which have appeared are those of Bethmann (*Zeit. Physikal Chem.*, v., p. 385), Bader (*ibid.*, vi., 289), and Walden (*ibid.*, viii., p. 433). At present more than 400 acids have been studied with respect to this affinity constant, and many interesting relations between the values of the constant, and the composition and constitution of the acids have been discovered.

Dr. James Walker, F.R.S.E., from whose recent paper before the Chemical Society the above is abstracted, has collected the results of a few more observations, which partly confirm these relations, and partly bring new regularities to light. He undertook in the laboratory of the University of Edinburgh the examination of a number of organic acids and derivations (*e.g.*, pimelic acid and its alkyl derivations), which are themselves chiefly interesting from a chemist's point of view, though the results obtained are of far reaching physical importance.

The method of measurement adopted by Dr. Walker was

precisely that described by Ostwald (*Zeit. Physikal Chem.*, ii., p. 561), the resistance being determined by means of a Wheatstone bridge and telephone, and the values of v, μ_v, μ_∞, m, k and K, in the above formulæ were carefully determined and tabulated.

We can scarcely follow Dr. Walker through the whole of the 22 pages in which he describes his work, but our readers can refer to it in the pages of the Chemical Society's Transactions, where they will be able to see to what extent the above relations are confirmed.

THE SPECIFIC INDUCTIVE CAPACITY OF ELECTROLYTES.

A NUMBER of experiments on the specific inductive capacity of electrolytes were carried out last year in the Physical Laboratory of the Johns Hopkins University by Dr. Edward B. Rosa, which formed the basis of a thesis afterwards submitted for the degree of Doctor of Philosophy. The experiments were undertaken with a view of enquiring into the behaviour of glass in a non-uniform electrical field in different liquids. The bulk of the paper, which has been reprinted in the *Philosophical Magazine*, deals with the mathematical aspect of the investigation; but we may notice some of the chief observations, as they are of a particularly interesting nature.

1. Glass cylinders in air, petroleum oils, bisulphide of carbon, turpentine and benzine are attracted; that is, move into the stronger parts of the field.

2. The force is least in air and greatest in turpentine; in short, is greater in those media having a greater specific inductive capacity, all, however, being considerably less than that of glass. This indicates that the principal change of energy is in the fluid medium.

3. In water, alcohol, and ether (the latter containing water and alcohol as impurities) glass is repelled, the forces of repulsion being nearly in the ratios of 9 : 3 : 1, respectively. In bisulphide of carbon containing about 20 per cent. of the same ether, glass is attracted; but with about 40 per cent. it is repelled.

4. The force of repulsion on glass in water is over 60 times as great as the attraction in air. Since this is, approximately, the value of the specific inductive capacity of water, it suggests, as in the case of glass in liquids of low specific inductive capacities, that the chief change in energy due to the presence of the glass is in the fluid media.

5. The force in the glass is proportional to the square of the difference of potential between the electrodes, and therefore to H^2, where H is the electric force.

In the case of water and alcohol this was verified quite accurately; and in the case of the other liquids, when the forces were much smaller it was verified approximately.

If the cylinder is a conductor, and is surrounded by a non-conducting medium, the lines of force are drawn towards it, as lines of magnetic induction are gathered up by a piece of iron put into a magnetic field. The resultant force is always one of attraction towards the electrodes. This follows from the tendency of the lines of force to shorten, and being more numerous on the side towards the origin, the conductor is drawn in that direction.

If the surrounding medium is a conductor, the case is not modified, providing the solid is a very much better conductor. Thus, suppose the cylinder is carbon and the medium water. The latter is a fair conductor, yet carbon conducts millions of times better than does distilled water, and the lines of force will be arranged sensibly, the same as though water were a non-conductor and carbon a perfect conductor. The resultant force on the cylinder in a given field will evidently be proportional to the specific inductive capacity of the medium of the field. This is a much simpler case than that of a dielectric solid in a liquid, when the conductivity of the liquid and the specific inductive capacity of the solid affect the result. As before, an accurate adjustment of the position of the conducting cylinders is not necessary, and using the same cylinders with the same difference (or known differences) of potential, this would seem to be an excellent method of measuring the specific inductive capacity of liquids. Accordingly, cylinders of carbon (cut out of an arc-light carbon) were mounted in the torsion balance, used by Dr. Rosa, and the force of attraction under various conditions measured.

1. The force, as we should expect, is accurately proportional to the square of the difference of potential for air and all liquids, conducting and non-conducting.

2. The force is approximately proportional to the volume of the cylinder. This was found, by Dr. Rosa, to be roughly true for three pairs of cylinders of nearly equal length, but of very different volumes, *i.e.*, 0·73, 5·7, and 10·0 cc. respectively. The force increased somewhat faster than the volumes, which might be expected, as the larger cylinders extend further into the stronger parts of the field near the electrodes. For small changes in the volume the force may be taken as proportional to the volume.

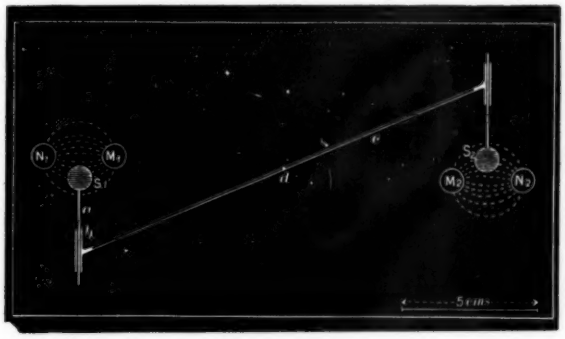
Dr. Rosa gives tables of a series of measurements made with a second pair of cylinders (volume 5·7 cc.) in air and turpentine. Other measurements agreed with them almost exactly.

The following values of specific inductive capacity were obtained :—

	Sp. in. capac., K.
Water at 16·5° C.	= 70·00
Alcohol about 93 per cent	= 30·90
Ether (with water and alcohol impurities)	= 8·4
Turpentine	= 2·39
Petroleum oil, 300° test...	= 2·04
„ „ light illuminating ...	= 1·97

Pure ether and pure alcohol have smaller values. The method employed is capable of giving tolerably accurate results, although it cannot be used for heavy oils.

The apparatus employed by Dr. Rosa in these experiments was as follows :—



Two pairs of electrodes, M_1, N_1, and M_2, N_2 (*vide* figure), made of platinum, 0·9 cm. in diameter, 5·0 cm. long, were placed so that their centres were 2·6 cm. apart. M_1 and N_2 were joined to one pole of the battery furnishing any desired potential up to 140 volts; N_1 and N_2 were joined to the other pole; and a rotating commutator served to give alternations of 50—100 per second. Two cylinders, S_1 S_2, of glass, mounted on glass stems, were carried on the arms of a torsion balance, d being the axis of rotation. The deflection was measured by a telescope and scale, and the force determined in absolute measure. The cylinders of glass were subsequently replaced by cylinders of paraffin, beeswax and other dielectrics, and carbon and brass, among conductors.

THE ELECTRICAL RESISTANCE OF PURE METALS, ALLOYS, AND NON-METALS AT THE BOILING POINT OF OXYGEN.

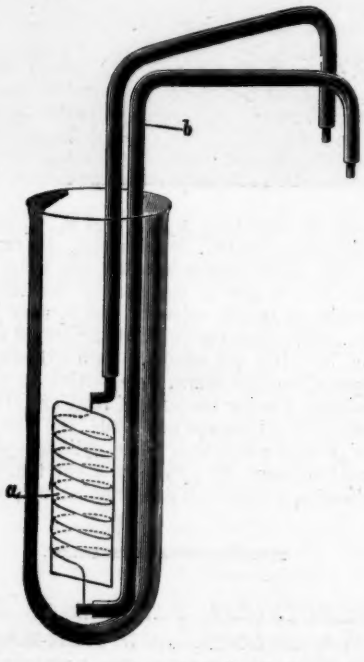
SEVERAL observers have studied the behaviour of metals as regards electrical conductivity at low temperatures. In particular, MM. Caillet and Bouty (*Journal de Physique*, July, 1885), have made observations of the resistance and resistance change with temperature of various metals at — 100° C., by the employment of liquid ethylene as a cooling agent. Wroblewski (*Comptes Rendus*, 1885, vol. ci., p. 161), measured the electrical resistance of wires of electrolytic copper

at various temperatures, 100° C., 20° C., 0° C., — 100° C., and gave, also, figures for the comparative resistance of the same wires at the critical point of nitrogen, the boiling point of nitrogen, and the temperature of the solidification of nitrogen.

The subject has recently been attacked in a more comprehensive way by Profs. Dewar and Fleming, who, being in the possession of means for producing very considerable quantities of liquid oxygen, as well as liquid ethylene, have taken the opportunity of carrying out some investigations on the comparative electrical resistance of a number of pure metals, alloys, and non-metals, at the low temperatures obtainable by the evaporation of liquid oxygen at ordinary barometric pressures, and the ebullition of liquid oxygen under reduced pressures of about 20 or 30 mm.

Since liquid oxygen, as already pointed out by Prof. Dewar, is a very perfect insulating fluid, it is quite a simple matter, if once sufficient of the liquid gas is obtained, to measure the electrical resistance of a wire or small rod of metal when immersed in it, and thus entirely at the same temperature as the evaporative liquid. A series of observations has accordingly been made by Profs. Dewar and Fleming, on the specific electrical resistance of various metals, non-metals, and alloys over a range of temperature varying from + 100° C. to nearly — 200° C., and although these investigations are as yet incomplete, the observations already made seem to be of sufficient interest to render it worth while placing them on record. This they have accordingly done in the October number of the *Philosophical Magazine*.

A number of small resistance coils were prepared, of different metals and alloys, in the following way :—A thin rectangular sheet of mica, about 5 cm. long and 1 cm. or 2 cm. in width, had a number of nicks cut in the edges, and round this was wound loosely the wire whose resistance was to be determined. The ends of the wire were brought out through two holes in the mica and soldered to two stout copper terminal wires formed of high conductivity copper wire well insulated with India-rubber. The ends of these terminal wires were bent over so as to dip into mercury cups (see figure). The resistance coil so formed could then be



lowered into a test tube full of the liquid oxygen or other fluid, by means of which the temperature of the wire was determined.

The majority of the wires used had a length of 50 or 100 cm., and a diameter of 0·003 inch. Their electrical resistance was measured by a Wheatstone's bridge, the coils of which were of platinum silver, and adjusted to read in B.A. units at 15·5° C. The balance was determined by the use of a highly sensitive mirror galvanometer, using the current from a single Helsen's dry cell.

The experiments were carried out in the Royal Institution laboratories in a room which remained approximately at about 20° C. during the whole time.

A series of wires of pure metals was obtained, and also others of known alloys. Those examined included annealed platinum, palladium, nickel, gold (999·9 degrees fineness) silver, tin, aluminium, electrolytic copper, annealed iron; also platinum-silver, iridium-platinum, rhodium-platinum, palladium-silver. Wires of commercial materials were also mounted, *e.g.*, German silver, platinoid, tinned copper, tinned iron wire, commercial tin.

Careful measurements and observations were made, the observed resistance being reduced to a corrected resistance in each case. The results are set out in tables, which give the specific resistances for constant mass at the various temperatures of the different pure metals, alloys and impure metals examined. The mean value of the various results is given, and the temperature in degrees Centigrade placed over the number denoting the specific resistance in absolute electromagnetic units.

By plotting these specific resistances out in a series of curves, Profs. Dewar and Fleming found (taking the absolute temperatures as abscissæ) that all the lines of resistance are more or less curved lines, which tend downward in such a way, as to show that if prolonged beyond — 200° C., they would probably pass through, or near, the origin or absolute zero. These resistance curves can be divided into three classes :—

1. Those of metals such as iron, nickel, tin, and perhaps copper, which are concave upwards.
2. Those of metals such as gold, platinum, palladium, and probably silver, which are concave downwards, towards the axis of temperature.
3. Those of metals such as aluminium, which are apparently nearly straight lines. In the case of a metal of the first class, such as iron, the resistance changes with the temperature, in such a way, that the rate of change of resistance with temperature increases as the temperature increases.

In the case of a metal of the second class, such as platinum, as the temperature increases, the rate of change of resistance with temperature decreases.*

The most interesting fact which these experiments have brought out is the enormous decrease in specific resistance experienced by the perfectly pure metals when cooled to these low temperatures. Thus the electrical resistance of a given pure iron wire at — 197° C. is only $\frac{1}{23}$rd part of that which it is at that at + 100° C. In the case of pure copper the ratio of resistance is about 1 : 11 for the same change of temperature. The very smallest impurity greatly affects this decrease. This is shown by observations on pure nickel deposited by Mond's new process, and on some supposed pure nickel; the latter, at — 182° C., had a specific resistance of 6,737 electro-magnetic units, whilst the former, at the same temperature, gave only 1,900 units.

For the perfectly pure metals, it seems probable that, as the temperature is lowered towards the absolute zero, the specific electrical resistance decreases, so that it either vanishes at the absolute zero, or reaches a very small residual value.†

In the course of their experiments, Profs. Dewar and Fleming found that the trend of the curve of specific resistance drawn with absolute temperatures as abscissæ seemed to give a good indication of the chemical purity of the metal.

The alloys were submitted to the same experimental treatment as were the metals. On charting the results, it was found that the resistance lines were very nearly straight with but little slope, not $\frac{1}{10}$th that of the pure metals when the constituent metals of the alloy were chemically very different. But when these were chemically similar, the re-

* This distinction between such metals as platinum and nickel, in respect of their variation of resistance with temperature, has duly been noted by Prof. C. G. Knott, *vide Proc. Roy. Soc.*, Edinburgh, Vol. xxxiii. (1888), p. 187. The observations of Profs. Dewar and Fleming, taken with those of Prof. Knott, show that the distinction extends over a very large range of temperature, viz., + 300° C. — 200° C.

† Clausius made the suggestion, in 1858, that the electrical resistance of all pure metals is proportional to the absolute temperature. This appears to be approximately true for only a few metals, and not at all for others, but it yet remains not improbable that the electrical resistance of all pure metals would at the absolute zero be either *nil*, or else exceedingly small.

sistance lines plotted in terms of the absolute temperature slope down at a much steeper angle, but never in such a manner as to indicate that if prolonged they would pass through the absolute zero.

The impure metals behaved in a similar manner.

Amongst other facts of considerable interest, we may notice the following :—We know that for temperatures above 0° C. carbon behaves like an electrolyte as regards change of resistance with temperature, *i.e.*, its specific resistance decreases as its temperature increases. Hence the behaviour of carbon was examined when cooled down to − 182° C. For this purpose Profs. Dewar and Fleming used the filaments of incandescent lamps, taking the "treated" filaments of Edison-Swan lamps, and the dense adamantine carbon employed in the Woodhouse and Rawson lamps. In both cases it was found that when cooled to this low temperature the specific resistance of the carbon continuously *increased* instead of decreasing, as do the metals.

Profs. Dewar and Fleming propose to examine, at similar low temperatures, the electrical resistance of such non-metals as selenion and sulphur, and such substances as arsenic and antimony, which, though metals, have marked affinities with the non-metals. Also the behaviour of such insulators as mica, glass, gutta-percha and India-rubber. It is known that the resistance of these bodies decreases with rise of temperature. It is not improbable that for such bodies may be found a maximum resistance at the lowest attainable temperature, and that it may prove to be the case that pure non-metals approach a maximum specific electrical resistance and pure metal a minimum in proportion as the absolute zero of temperatures is approached. In any case, it is a matter of considerable interest to complete the examination of the change of conductivity with diminished temperatures for all the metals in a state of the greatest chemical purity.

The most striking illustration of the effect of great cold on electrical conductivity is shown by Profs. Dewar and Fleming is, perhaps, that at the temperature of boiling liquid oxygen, pure iron conducts electricity better than the present electrolytic copper does at ordinary temperatures.

THE THEORY OF LEAD ACCUMULATORS.

M. BIDARD, Professor of Chemistry at Rouen, has laid down the following theory, which, if it is acknowledged to be correct, will lead to important improvements in the construction of accumulators.

In his article, the writer shows that there exists a theory, which is confirmed by practice, and which fully explains the phenomena that take place in lead accumulators, and he does not hesitate to assert that this theory, when fully understood, will bring about the following improvements :—

1. The reduction of the volume and weight of the accumulators.

2. Easier mode of conveying the current with no alteration of the lead.

3. And, which is of capital importance, the rendering at the discharge approximating to the theoretical rendering.

First of all, he lays down as an absolute principle that the accumulator is only possible with the lead immersed in sulphuric acid, and that with other metals there can be no accumulation.

The theory of accumulators is very simple, and may be defined in a few lines as follows :—When we make a current pass through some insulated plates of lead immersed in sulphuric acid, the acid is decomposed into sulphur, which combines with one of the plates to form a black sulphate of lead and oxygen, which attaches itself to the other plate so as to produce a puce-coloured bioxide of lead.

The chemical formula is established as follows :—

$$2\,SO^3 + 5\,Pb = 2\,S\,Pb \text{ black sulphate of lead}$$
$$3\,Pb\,O^2 \text{ puce-coloured bioxide of lead.}$$

This reaction manifests itself to the eye by two well defined colours, black and puce. Moreover, it is indicated by analysis. In several experiments, he noticed always this important fact : after the charge, the weight of the accumulator has increased by a quantity equal to that of the sulphur and oxygen deposited on the lead, and consequently, part of the sulphuric acid has disappeared from the liquid, and we find its elements in the sulphate of lead and the bioxide of lead.

When we discharge the accumulator, the two elements, sulphur and oxygen, fixed on the lead, combine to reconstitute the sulphuric acid.

This second reaction also manifests itself to the eye by the discolouration of the two plates, which resume their original colour.

These are very important experiments and can easily be reproduced with small accumulators arranged in glass vessels so as to show the reactions described. M. Bidard says that accumulation is only possible with lead, because lead, sulphate of lead and bioxide of lead, are neither attacked nor even affected by sulphuric acid. This is not the case with copper, iron, or zinc, which cannot resist the action of sulphuric acid, as it dissolves their oxides. The lead accumulator, which is the only practical one, shows true foresight ; lead is the only metal which enables both electricities to be held in two solid combinations, sulphate of lead and bioxide of lead, which are insoluble in sulphuric acid.

The lead should be as pure and as finely divided as possible. We must avoid using lead left over from castings, waste, residues, old pipes, gutters, &c. ; for such lead always contains appreciable quantities of zinc, and even antimony, which give rise to inconvenient reactions and facilitate the destruction of the plates. The sulphuric acid of commerce is sufficiently pure ; it contains sulphate of lead, which is separated when we mix it with water to bring it to 10°. It must be removed by deposition or filtration, in order that it may not form an adherent film on the plates, which would prevent any accumulation.

Before accumulators can be brought to perfection, several problems remain to be solved. These are :—

1. What is the quantity of electricity accumulated for one equivalent of lead ?

2. By what process can we obtain the most finely-divided lead ?

3. The preservation of the plates, when they are not in use ; cleaning without taking to pieces, in order to remove the sulphate of lead.

4. When employing sulphuric acid at 10°, under the influence of the current, there is always electrolysis of a certain quantity of water and some electricity lost ; we should, therefore, try whether this accident can be avoided by using acid of greater density.—*Bulletin International de l'Electricité.*

TEST OF A SPRAGUE No. 6 STREET-CAR MOTOR.

IN the *Electrical Engineer*, of New York, for October 12th, there appeared very complete particulars of a test of two No. 6 Sprague double reduction street car motors, and we are indebted to this article for the following interesting details.

The trials were carried out by Dr. Louis Duncan, Mr. Carichoff, and Mr. Cary T. Hutchinson, and the method employed was similar to that referred to by us on pages 371 and 372 of the ELECTRICAL REVIEW.

The manner of making the test was explained there, and it is only necessary to reprint the formula for the efficiency,

$$\phi = \tfrac{1}{2}\left[1 + \frac{C_2}{C_1} - (C_1 + C_2)\,\frac{R_o + r_o}{E}\right]*$$

Where ϕ is the efficiency of the motor,
C_1 is the current in the dynamo,
C_2 is the current in the motor,
E is the P.D. at motor terminals,
R_o is the standard field resistance,
r_o is the standard armature resistance.

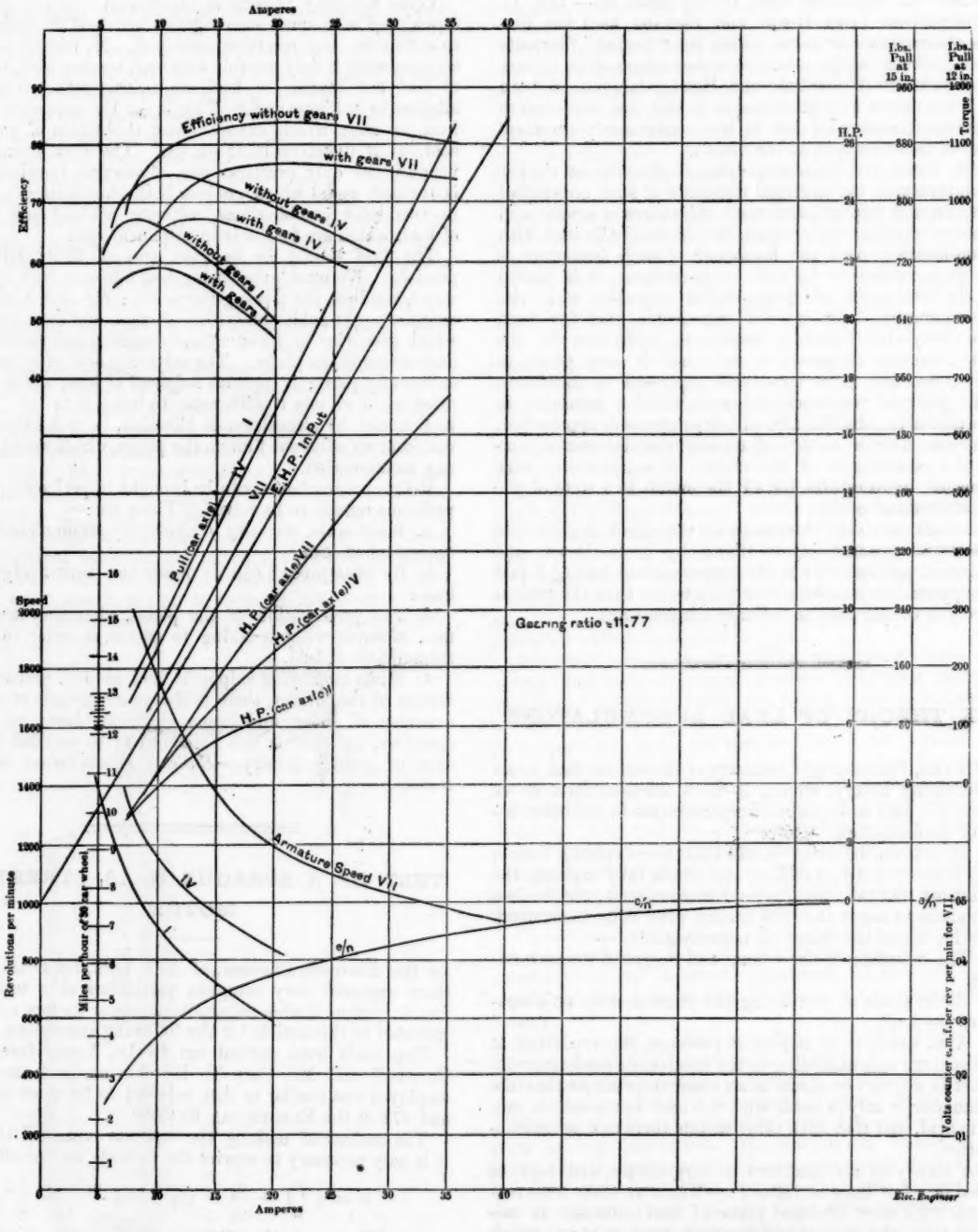
Now, the Sprague tram motor is of the single magnetic circuit type with the two cores, connected by a yoke. Each core is wound with three coils of No. 14 B.W.G. wire, having 11 layers and 31 turns, or 341 turns ; and

* See diagram on page 371, ELECTRICAL REVIEW.

the six coils are coupled into three main coils severally distinguished by us as A, B, and C, each having 682 turns.

The Sprague motor, it will be remembered, is regulated by commutating the field coils; the switch positions are :—

1. A + B + C. Three coils in series.
2. B + C. One coil short circuited.
3. B + C. One coil cut out.
4. $\frac{A}{B}$ + C. Two coils in parallel and one in series with them.



5. $\frac{A}{B}$ Two coils in parallel and one short-circuited.
6. $\frac{A}{B}$ Two coils in parallel and one cut-out.
7. $\frac{A}{B}$ / C Three coils in parallel.

It will be seen at a glance that the proper working positions for the switch are positions 1, 4 and 7, which give respectively 2,046, 1,364, and 682 turns, the corresponding resistances being 11·5, 6·1 and 2·15 ohms. The remaining "blocks" on the switch are simply for making the necessary changes in the connections without opening the circuit.

The armature is drum wound with 448 turns of No. 14 B.W.G. wire, and 56 coils. The iron is 8·75 inches in diameter by 10·25 long, and has an effective cross-section of about 51·5 square inches. The bore of the pole pieces is given as 10 inches, and the gap as $\frac{5}{8}$ths inch.

The running resistance of the armature varies between ·75 and ·93 ohm, while the field coil resistances alter as much as 40 per cent., from the heating effects.

Owing to this large fluctuation in resistance, it is obviously of importance to determine the efficiency for a definite temperature, and the method of testing adopted admits of this with considerable accuracy. Referring to the equation, we see that R_o and r_o can be varied to suit the instantaneous values of resistance measured at the moment of taking the readings of E.M.F. current, speed, and load.

A striking feature about the motor is the high internal resistance, even with the field coils in three parallels, say

3·05 ohms in all. It is also apparent that there is no need of external resistance at starting, since the total resistance is then about 12 ohms; and so with a line potential of 500 volts, the possible current is only 41 ampères at starting.

The results of the test are shown in the diagram, which will repay a close study.

$$\text{The armature flux} = 13{\cdot}4 \times 10^6 \frac{\text{counter E.M.F.}}{\text{revs. per min.}}$$

The armature induction in C.G.S. lines per square inch

$$= \frac{\text{flux}}{51{\cdot}5}$$

Miles per hour of car, with 30-inch wheels

$$= \frac{\text{armature speed}}{132}$$

The six curves in the upper left hand corner are the efficiencies, with and without gearing, for positions 1, 4, and 7.

The three lines below these curves give the corresponding pull at the car axle for the several positions; and immediately beneath these is the curve of input in E.H.P.

The next three curves show the B.H.P. for the three positions; and below these are the speed curves. The curve, e/n, is what the authors call the characteristic of the machine. The back E.M.Fs., divided by revolutions per minute, are plotted as ordinates, and the corresponding current values as abscissæ; and the switch is in position 7, so that the ampère turns are given by current × 682.

On examining the curves it will be seen that an efficiency of about 75 per cent. is obtained between outputs of 6·5 and 16·5 B.H.P. on the car axles.

CENTRAL ELECTRIC WORKS AT FRANKFORT-ON-MAIN.

REPORT OF THE MIXED COMMISSION OF THE MAGISTRACY AND THE MUNICIPAL REPRESENTATIVES.

[FROM OUR OWN CORRESPONDENT.]

THE mixed commission of the magistracy and the municipal representatives, appointed for the preliminary consideration of the erection of a central station for supplying electric light and motive power, appointed on January 8th, 1887, and re-elected on April 7th, 1891, came to a conclusion on June 30th of the present year (1892) on the basis of the report presented by the experts appointed, *i.e.*, W. H. Lindley and Oscar von Miller, and have now the honour of laying the result of their deliberations before the magistracy and the meeting of municipal representatives.

Before proceeding to their conclusions and the evidence on which they are founded, the report gives a very prolix history of the previous negotiations and deliberations from which we extract the more salient points.

The first step in this direction was taken by Herr Mochring, of Frankfort, on September 8th, 1882. He offered the magistracy to provide a part of the city with electric lighting. It may here be remarked that on October 19th of the same year a notification was received from the Imperial Post Office that the execution of such a project must depend on its consent, lest the telegraph and telephone arrangement might be interfered with.

Mochring renewed his offer on October 12th, 1882, declaring himself prepared to light up the square in front of the Opera House as a specimen. His proposal was declined by the authorities on the ground of the expense. He subsequently offered to try the lighting for a time at his own expense. A plot of land was, in fact, placed at his disposal, but the project seems not to have come to execution.

On December 17th, 1883, J. Valentin applied for a concession to erect electric works in the Holzgraben, No. 11, to light the Zeile and the Liebfrauenstrasse. But nothing was actually done.

On December 8th, 1886, the authorities began to consider the erection of a central station on their own account, and considered tenders received from the Berlin Edison Company, and from the Helios Company. They resolved on the appointment of a mixed commission representing both the magistracy and the municipality. This joint commission submitted its first report on October 26th, 1887, and on October 28th the magistracy resolved to apply for tenders, and added Prof. Kittler, of Darmstadt, as expert to the commission. The latter inspected the electric works at Rome, fitted up by Ganz & Co., of Budapest, on the alternating current system.

In 1889, the commission recommended:—

1. To erect a central station in the city sufficing for all the streets shown in the appended plans at municipal expense, and to work it on account of the city.

2. To empower the joint commission to obtain special plans and estimates, and to negotiate with some experienced and responsible firm, laying the result before the authorities.

In January, 1889, the magistracy and the municipal representatives came substantially to the same conclusion.

On June 8th, 1889, the joint commission reported on the execution of its task. The commission resolved, in the first place, to obtain tenders from Siemens & Co., Schuckert and Co., and Ganz & Co., or from the firm Helios, connected with the latter. To this end an invitation, with a schedule of conditions, was drawn up by Herr Lindley and approved by the commission. The invitation required a central station for about 22,000 lamps for lighting the streets marked on the accompanying plan, but, further, that the possibility of extension should be kept in view. Tenders were received from Siemens and Halske, and Schuckert & Co. (continuous current), and from Ganz & Co., with Helios (alternating current).

The question first arose which system was preferable. At first the commission seemed to incline more to the continuous current, but a closer investigation led to a preference for the alternating current. It was found that the dangers to life and property apprehended from alternating currents were now excluded. Its applicability to arc lights was shown practically, as also its use for motor purpose, for propelling tramcars, &c. It was seen that the entire city and its liberties might, on the alternating system, be supplied from a single central which is not practicable with a continuous current. The alternating current may, in an indirect manner, be made available for charging accumulators.

As regards cost, the two systems differed little from each other. But the alternating current can be supplied from a single plot of ground *outside* the urban territory.

The commission proposes, as the fundamental price for electric energy supplied, $\frac{1}{100}$ shilling hourly for a 16 normal candle glow lamp. The total cost, including the ground, would be probably $2\frac{1}{4}$ million marks (= shillings).

The joint commission therefore recommended:

1. That alternating current should be selected for the central station.

2. That the commission be empowered to negotiate with Ganz & Co., of Budapest, on the basis of their offer, and to conclude an agreement accordingly.

. . . . .

4. The price of lighting must be fixed at $\frac{1}{100}$ mark (= shilling) hourly for a 16 candle lamp. The allowance of discount to be reserved for future consideration.

. . . . .

6. The existing joint commission for an electric central remains in activity, and is entrusted with the execution of the resolutions.

These proposals of the joint commission excited a violent agitation in electro-technical circles. The adoption of the alternating current was strongly opposed by the firms which had recommended a continuous current, whilst the other side replied no less emphatically. The assemblage of municipal representatives could not resolve on a decided conclusion.

Further deliberations were resolved upon. New experts were added to the commission. Prof. Galileo Ferraris, of Turin; Prof. Weber, of Zurich, and F. Uppenborn, director of the Electrotechnical Experimental Station at Munich, who, in conjunction with the former experts, Kittler and Lindley, were to answer a series of questions.

During these negotiations a supplemental offer, based on the use of accumulators, was (somewhat irregularly) sent in by Müller and Einbeck, of Hagen.

The new commission of experts met in October, 1889, at Frankfort, and before coming to a conclusion, undertook a series of experiments for which the firms of Ganz & Co. (or Helios), Schuckert & Co., Siemens and Halske, Müller and

Einbeck, placed their appliances and machinery at disposal. These firms took part, by their officials and representatives, in the experiments, for which a special laboratory was erected. The experiments were made by the five experts of the commission, assisted by the civil engineer, Kasten, and the mechanical engineers, Bender and Schiele. The results were then submitted to the commission, November 10th, 1889.

Twelve questions had been submitted to the experts, in replying to which they were perfectly unanimous, with a single exception. It would be too tedious to give in detail the replies to these questions. In fine, the commission declared that the objections against the alternating project of Ganz & Co. raised by their opponents and by a portion of the Press, were not justified.

The work of this last commission was very much facilitated by the prolonged preliminary investigations. The problem was solved in a short time, and a report was issued in the beginning of June.

In all the three competing projects provision is made for a consumption of 38,000 lamps burning simultaneously, the conductive net in the streets being made from the first of sufficient dimensions to admit of such an extension. The installation will be arranged only for 21,000 to 25,000 lamps burning simultaneously. When completed, the installation is calculated for 67,000 lamps burning simultaneously. The three projects are :—

a. The alternating current transformer project.

b. The project with accumulators, secondary stations, and direct conveyance of current.

c. The project with accumulators, secondary stations, and alternating current continnous current transformers.

The costs of the installations on a most careful estimate amount to :—

For project *a*—

2,996,000 marks in the first, and
6,903,000 „ „ complete erection.

For project *b*—

4,685,000 marks in the first erection, and
11,332,000 „ „ complete erection.

For project *c*—

4,097,000 marks in the first erection, and
9,110,000 „ „ complete erection.

The joint commission is in complete accord with the experts ; the execution of the alternating transformer project is the only system suitable for the local conditions. It is significant that all the different experts who have been consulted in this affair have ultimately recognised the advantages of the alternating current system with transformer. At first the architect, Lendley, and the privy councillor, Kittler, then the commission which included these gentlemen, and also Ferraris, Uppenborn and Weber. It was very important for the joint commission that everyone had had the opportunity at the recent electrical exhibition to observe daily for months several large alternating current installations, similar to the machines now on view, and their yield of arc light, glow light, and motive power, and to compare the performances of other generators of current. Further had to be considered the opinions of the most eminent experts, native and foreign, at the conferences held in connection with the exhibition. We particularise here merely the discourse on the alternating current delivered by Silvanus P. Thompson.

The general change of opinion in favour of the alternating current system has been recently shown by the fact that several firms which formerly posed as the chief opponents of the alternating current system, not merely displayed at the exhibition extensive alternating current installations, but that they, and other firms of similar opinion have, in competitions for lighting up other cities, been concerned in alternating current projects. It was also felt that whilst formerly it was necessary to refer to distant countries for instances of the success of the alternating current system, two extensive centrals on this system have been opened with successful results in Cologne and Vienna, not to speak of some smaller installations.

The commission cannot, of course, guarantee the calculation which shows for the alternating system a return of $7\frac{3}{4}$ per cent. in the first stage, and 8 per cent. on completion (exclusive of interest and sinking fund), yet favourable results may be expected after the instances of Cologne and Vienna, and in view of the large consumption of current to be expected in Frankfort.

Of the other systems, only the rotatory current system (used in the Lauffen installation for the transfer of power) could come in comparison with the alternating system. The experts justified its rejection on the ground that it requires three leads, which render insulation more costly and the distribution of the current more difficult.

It does not seem necessary to discuss systems *b* and *c* more closely, since the considerably greater expense, without commensurate advantages, speak strongly against this system. Both involve great losses in working, which seem inseparable from the systems.

Fears were expressed in some quarters that the light furnished from a central would not be steady enough for certain local industries—the graphic, lithographic and light printing establishments. We assume that the engines and dynamos to be used in the proposed central will be of such a quality, that the light will be steady and uniform. But if in any case a light fed by accumulators is absolutely needful, the current derived from the central may be converted into a continuous current by the consumer, and this again may be used to feed the accumulators.

The question has, of course, not been discussed by the commission whether the central is to be worked on municipal account, or be entrusted to a contractor. Three years ago few central stations were carried on by the communities. Since then a large number have been erected, and a still larger number are in course of preparation. Among these municipal establishments we may mention, in addition to a series of smaller towns, those of Barmen, Elberfeld, Darmstadt, Breslau, Bremen, Düsseldorf, Königsberg, Lübeck, Hamburg, Hanover, München, Schwabing, Cassel, and Cologne.

It must be admitted that at Hamburg (where there are two centrals) it is proposed to let the one in the interior of the city, which has been very imperfectly laid down, to a private capitalist. The affair is, however, by no means concluded.

As to the proposed price of $\frac{4}{100}$ shilling hourly whilst the lamps are burning, it stands on the same footing as that laid down in the projects of former undertakers. A very considerable remission is offered to large consumers, by the proposed discounts up to 30 per cent. On completion of the installation, a reduction of 25 per cent. is assumed, so that the fundamental price per lamp-hour will be $\frac{2\cdot6}{100}$ shilling on the average. The calculation is, in fact, not made according to hours of burning, but according to watts, whence all the advantages resulting from the use of glow lamps of modern construction (requiring a reduced consumption of energy) accrue to the consumer, which is not the case when the calculation is really made according to hours of burning. For instance, the General Electrical Company, and the Maatschaffij de Khotinsky, of Gelnhausen, use already glow lamps, which are admittedly less durable, but which consume only 25 watts, and where they are in use the hour's burning, even in the first period (leaving discount out of the question), will be only $\frac{2}{100}$th of a shilling. A further advantage for consumers in connection with the municipal central will be that no so-called lamp-tax is required. No minimum number of burning-hours is demanded ; the consumer can withdraw at any time, and therefore has not to bind himself for any fixed time. In opposition to these advantages, some "block stations" which are proposed, or are in course of erection in this city, scarcely come into consideration. The fear has certainly been expressed in some quarters that the best consumers will be withdrawn beforehand from the municipal central, so that it will be restricted to the less profitable parts. We believe that in this respect the city may calmly look forward to the development of the electrical works. Firstly, as it is already apparent from the published conditions of the block stations, they will charge higher prices than the municipal works ; these higher prices must remain unaltered, as the conditions of production can scarcely be modified after the erection of the block stations. The municipal central, on the contrary, will be able to reduce its charges with its progressive extension, and with the increasing use of electric motors. Further disadvantages of the block stations are that the subscribers will have to pledge themselves for a term of years, and for a minimum consumption. The block stations, in general, could be enlarged only with much trouble and at

a serious expense, so that they cannot accommodate themselves to an increasing demand. Even one of the most favourably situated of such block stations—that, namely, in Berlin, at the corner of the Friedrichstrasse and the Linden, was given up in consequence of the heavy expense of the production of current after the leads of the central had been extended in this direction. Of the 29 local installations existing in Cologne, six connected themselves with the central in the very first year. (See "Municipal Electrical Works," by J. Stübben, Cologne, 1892.)

A very important advantage of the project of H. H. Lindley and Oscar von Miller is that—unlike other cities, *e.g.*, Cologne—the majority of the transformers will be placed not in the houses, but in separate receptacles in the streets.

It deserves mention that the authorities have caused the opinion of the experts, along with all the evidences upon which it is founded, to be printed, so that it may be examined by all interested parties and submitted to public criticism.

As for the erection and the conduction of the municipal installation, the joint commission propose that as soon as the necessary credit is granted a municipal deputation should be formed in a similar manner to the labour deputation, and should undertake the over-looking of the construction and of the subsequent working. An efficient managing director should be attached to the deputation with a suitable staff whilst the works are in progress.

On the basis of these expositions we propose that the chief municipal authorities :—

1. Sanction the regulations for the erection and management of municipal electrical works.

2. Consent to the erection of a municipal central for electric lighting and the transfer of power on the plan submitted by H. H. Lindley, the municipal councillor of architecture, and Oscar von Miller (alternating transforming project A) ; the first portion to be erected on the plot of town land on the Speicherstrasse, and grant for the erection in the first place 2¼ million marks.

3. To conclude on an immediate application for candidates for the post of managing director.

Frankfort-on-Main, August 20th, 1892.

The commission : Adickes, head burgomaster ; Dr. Zitelmann ; Heinrich Flinsch ; Martin May ; Gustav Marck ; Dr. Humser (councillor of justice) ; Leopold Sonnemann (reporter).

Regulations concerning the construction and management of Municipal Electric Works at Frankfort-on-Main.

Section 1. For conducting the erection and management of a municipal central for electric lighting and the transmission of power, a committee is formed according to section 66 of the constituting law of the community, bearing the name "Municipal Electric Works."

Section 2. The committee consists of nine members, that is to say : two members of the magistracy ; three town councillors ; two inhabitants of the city ; one municipal councillor of architecture, and the managing director of the electrical works.

Section 3. The two members of the magistracy and the architectural councillor (section 2) are nominated by the chief burgomaster, who also selects one of these as chairman.

The town councillors and inhabitants (section 2) are elected by the municipal council for a term of four years. Half of them retire every two years, that is, one after the two first years, two of the town councillors, and the remaining one after the fourth year. The retiring members are selected firstly by lot, and afterwards by length of service, and are capable of re-election. Extraordinary elections (to supply a vacancy) hold good only for the unexpired term of office of the members resigning.

Section 4. At least half the members of the committee must be present to form a quorum.

Resolutions are passed by a majority of votes. If the numbers are equal, the chairman has a casting vote.

Section 5. The chairman represents the committee, and signs the documents which it issues. He is authorised, in case of need, to take at once the measures which may be required, reserving subsequent communication to the next meeting.

The immediate conduct of business is entrusted (under the inspection of the chairman) to the managing director (section 2), who will be appointed under agreement, and whose salary will be determined by the municipal authorities

The director is the immediate superior of all the technical and managing staff.

Section 6. Separate accounts must be kept for the electrical works within the municipal economy. A thorough report on the building and working is to be laid before the municipal authorities for each financial year.

Section 7. The committee, with the consent of the magistracy, is empowered to allot work and supplies for the electric works, and to conclude the necessary agreements, as also to engage the hands necessary for the building.

THE COST OF ELECTRIC SUPPLY.*

By Dr. JOHN HOPKINSON, F.R.S.

ELECTRICAL engineers now realise that they have to provide the same plant and no more to give a steady supply day and night, as to give a supply for one hour out of the twenty-four. They also now realise that if they are to be ready to give a supply at any moment, they must burn much coal and pay much wages for however short a time the supply is actually taken. Indeed, the term "load-factor" proposed by Mr. Crompton is as constantly in the mouths of those who are interested in the supply of electricity, as volt or ampère or horse-power. The importance of the time during which a supply of electricity is used was so strongly impressed on my mind years ago, that in 1883 I had introduced into the provisional orders with which I had to do, a special method of charge intended to secure some approach to proportionality of charge to cost of supply. Unfortunately the orders of that day all came to nought.

A supply of electricity must be delivered at the very moment when the consumer chooses to use it, and as long as and no longer than he pleases to use it ; it cannot be very readily or cheaply stored, and much of the cost of production is the fixed charge for plant and conductors. Furthermore the provisional orders require that the supply shall be available at all hours ; hence coal must be consumed and workmen must attend, though but few consumers are drawing a supply. The service of supplying electricity has from an economic point of view a great deal of similarity to the service of providing a breakwater for a harbour. A great deal of the expense is independent of the number of hours in the day during which the supply is used. To put it in another way, the cost of supplying electricity for 1,000 lamps for ten hours is very much less than ten times the cost of supplying the same 1,000 lamps for one hour, particularly if it is incumbent on the undertaker to be ready with a supply at any moment that it is required.

The actual importance of considerations of this kind can only be realised by examining figures. The figures may as well be estimated figures, because the circumstances vary from one neigbourhood to another. No criticism of the details of the figures will affect the general character of the conclusion. Let us then imagine a station capable of supplying 40,000 16-candle lamps at one time, with mains and spare machinery enough to ensure that the supply shall not fail, and let us see what the charge for running such a station will be ; firstly, on the hypothesis that it is always to be ready to supply the 40,000 lights at half-an-hour's notice, day or night, but the lights are hardly ever actually required ; secondly, on the hypothesis that the 40,000 lights are steadily and continuously supplied day and night. These are the two extreme cases possible. In the former, the load factor is nil ; in the latter it is 100 per cent. If the charge is by meter at 8d. per unit in the former case, the revenue will be nil ; in the latter it will be £730,000 a year.

We are going to divide the cost of supplying electricity into two parts ; a part which is independent of the hours the supply is used, and a part which is directly proportional thereto ; and we are going to estimate the amount of each element. It is for the purpose of ascertaining these elements that we consider two quite hypothetical cases ; cases which can themselves never actually occur.

We must first have an idea of the capital outlay required. To provide the maximum of 40,000 lamps we need to deliver 2,500 units per hour, and we may estimate the capital outlay as follows :—

Land	£25,000
Buildings	15,000
Boilers and pipes	14,000
Engines	24,000
Dynamos	15,000
Switchboard and instruments ...	2,000
Feeders and mains	50,000
	£145,000

Let us deal with the annual charge for each item of capital separately on the two hypotheses. The charge for land and for buildings, including repairs, is clearly the same in the two cases, say at 4 per cent. £1,000 for the land, and at 10 per cent. £1,500 for the buildings. The boilers, engines, and dynamos will have a charge for interest and a charge for writing off, or amortisation as the French call it, that

* Presidential Address to the members of the Junior Engineering Society, delivered November 4th, 1892.

is, for writing off the value of the plant before the time at which it becomes antiquated—exactly the same in the two cases. The boilers too will require exactly the same repairs whether they are merely keeping steam or whether they are generating steam continuously; but the machinery will certainly require more for repairs and renewals if it is all running than if a part only is running without load and the rest is standing ready for a load if required. I take 4 per cent. as the charge for interest; 3 per cent. for amortisation; 8 per cent. for repairs and maintenance. Of the repairs of engines and dynamos I assume that 2 per cent. will be applicable if the plant runs light, the remaining 6 per cent. if it is fully and continuously loaded. The expenses connected with conductors, switchboard, &c., will be exactly the same whether the current is passing or not; these I take at 15 per cent. The rates I put down at £500 a year. The account then for the fixed charges already enumerated would stand as follows:

	Running light.	Fully loaded.
Land	£1,000	£1,000
Buildings	1,500	1,500
Rates	500	500
Boilers	2,100	2,100
Switchboard and conductors ...	7,800	7,800
Engines	2,160	3,600
Dynamos	1,350	2,250
	£16,410	£18,750

We now come to a most important item in the account, the coal. There is no doubt that with uniform and continuous load a unit of electric energy—1¼ horse-power for one hour—can be produced for less than 3 lbs. of coal; it is also pretty much admitted that with a load factor of about 12 per cent., but continuous maintenance of pressure, the consumption of coal in good practice is something like 7 lbs. That is to say, to keep the boilers warm, turn round the machinery for 24 hours, and deliver full current for 24 hours, will require 72 lbs. of coal per kilowatt; whereas to keep the boilers warm, turn round the machinery, and deliver current for 3 hours, will require 21 lbs. of coal. The boilers being kept warm, it will take 51 lbs. of coal to generate steam enough to give a unit per hour for 21 hours; 58 lbs. to give a unit per hour for 24 hours; subtracting this from 72 lbs., the amount required both to generate steam and keep the boiler warm, we may infer that to keep the boiler warm and merely turn the machinery in readiness to meet a demand will take about 14 lbs. of coal per day for every unit per hour the plant is capable of producing. In 1889, for the Society of Arts, tests were made of a Paxman compound engine, from which it appears that a boiler which, when fully loaded consumed 40 lbs. of coal per hour, required 4 lbs. per hour to keep steam up to normal pressure when the engine was standing: that is, 10 per cent. of the coal used was used to maintain the steam pressure. Remembering that in addition we keep some of our machinery moving, this may be said to confirm the figures adopted. Thus if the plant runs light all the year round 12,775,000 lbs., or let us say 6,000 tons of coal will be consumed. If the plant runs fully loaded 65,700,000 lbs., or let us say 30,000 tons would be consumed. If we suppose the coal to be best smokeless it might cost 20s. per ton. Next we have water, oil, and petty stores; say £600 and £3,000 in the two cases. Wages will be a little less if we run light than if we run fully loaded, and of course will largely depend on local circumstances; let us say £5,000 and £7,500 in the two cases. This gives us substantially all the expenses which have to be met, and our account will then stand thus:—

	Running light.	Fully loaded.
Fixed charges	£16,410	£18,750
Coal	6,000	30,000
Stores	600	3,000
Wages	5,000	7,500
	£28,010	£59,250

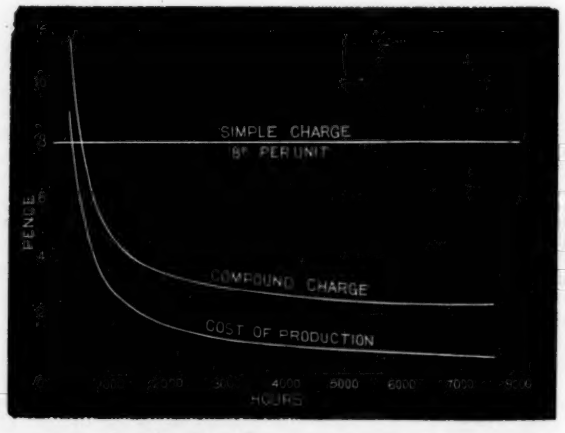
Thus the cost of merely being ready to supply 2,500 units per hour at any moment throughout the year will be £28,010, and the cost of actually supplying 2,500 units per hour for every minute in the year will be £59,250. The undertaker therefore who incurs the liability to supply, ought to receive £11 per annum per unit per hour from those on whose behalf he incurs the liability, and if he receives the £11 he need not charge more than ¼d. per unit for what he actually supplies, to cover his expenses. That these figures are fair approximations can be seen as follows: according to this calculation the cost of supplying 2,500 units for one hour per day is £28,010 + 2,500 × 365 × ¼d. = £29,277, and the charge for the service at 8d. a unit would be £30,417; it is doubtful if such a supply would pay. On the other hand an indicated horse-power on such a scale could certainly be supplied continuously for from £12 to £14 per annum, and according to this calculation an electrical horse-power will cost just under £18 per annum. No account is taken of expenses peculiar to companies, such as directors' fees and the cost of forming the company. It will also be noted that it is assumed that accumulators are not used.

The charge for a service rendered should bear some relation to the cost of rendering it. If it is a matter of open competition the matter will settle itself, for no one will for long be able to supply some customers at a loss, and recoup himself by exorbitant profits from others. If the matter be a case more or less of monopoly, the adjustment is less certain; thus the Post Office charges ½d. postage for a printed circular and 1d. for a written letter, the two costing the Post Office exactly the same. What a boon to the public it would be if the Post Office would charge more for printed trade circulars, which in nine cases out of ten are a nuisance to those who receive them. The supply of electricity is not quite a monopoly; companies compete with each other, and there is always the competition with other methods of illumination such as gas and paraffin. It is clearly to the advantage of the undertaker to secure all those customers whom it pays best to supply, and as far as may be, to compel those who are unremunerative to adopt these other methods. The ideal method of charge then is a fixed charge per quarter proportioned to the greatest rate of supply the consumer will ever take, and a charge by meter for the actual consumption. Such a method I urged in 1883 and obtained the introduction into certain provisional orders of a clause sanctioning "a charge which is calculated partly by the quantity of energy contained in the supply, and partly by a yearly or other rental depending upon the maximum strength of the current required to be supplied." In fixing the rates of fixed charge it must not be forgotten that it is improbable that all consumers will demand the maximum supply at the same moment, and consequently the fixed charge named might be reduced or some profit be obtained from it. There is no object in reducing the cost of electricity for lighting in the case of any customer much below the cost of equivalent lighting by gas, unless there are competitors in the field willing to do it, hence the current charge proportioned to the power supplied may safely be increased. In certain recent cases in which I am acting as engineer, the Board of Trade have sanctioned, on my application, "for each unit per hour in the maximum power demanded, a charge not exceeding £3 per quarter, and in addition for each unit supplied, a charge not exceeding two pence." It is sometimes said as an objection to this method of charge, the public will object to pay a fixed charge whether they make use of their lights or not, and that in fact they will not pay it. The best answer that can be made is to give everyone the choice of being charged the maximum simple rate provided by the order, or by the compound rate as they prefer. What is wanted is not so much an increased charge for those consumers whose lights are used for a short time, as such a special reduced charge for those whose lights are used long as will induce them to use the supply.

It is instructive to compare the cost to different classes of consumers of electricity and gas for lighting with 16-candle gas. Flat flame burners must be large and of first rate quality to give more than two candles per cubic foot of gas per hour; the large majority of burners give much less than this even at their best, and, as a rule, the pressure of the gas is not regulated, and much gas is wasted as far as the production of light is concerned. Incandescent lamps give about one-quarter of a candle per watt; hence a Board of Trade unit is equivalent to 125 cubic feet of gas. Thus we readily arrive at the following comparative table, the charge being at the rates recently sanctioned by the Board of Trade:—

Hours of use per annum.	Load factor.	Price of gas at which cost of lighting by electricity and 16-candle gas are equal.
480	5·5	5s. 4d.
960	10·9	3s. 4d.
1,440	16·4	2s. 8d.
1,920	21·9	2s. 4d.
2,880	32·9	2s. 0d.
3,840	43·8	1s. 10d.
7,680	87·6	1s. 7d.

In the accompanying curves are shown the cost of production, and the charge per unit at the compound and simple rate. The ordinates represent pence, and the abscissæ the number of hours per annum the supply is used.



It is obvious that those whose user is long will find the electric light economical to themselves, and that it will be profitable to the undertaker. With a cheap light which is free from the products of combustion there will be extensions for the hours of use. Shops may find it worth while to continue the light after closing, as an advertisement.

We have so far assumed that the supply of electricity is carried on without the aid of accumulators. Let us first compare the cost of an

electric accumulator with the cost of a gas-holder containing the same possibility of producing light. A gas-holder is at present being put up in Manchester to hold 7,000,000 cubic feet of gas, and is to cost, complete with its tank, £60,000. With 16-candle gas, seven million cubic feet are equivalent to 56,000 Board of Trade units. Accumulators capable of storing a ten hours' supply, cost about £50 per unit. The equivalent accumulator will, therefore, cost about £280,000. But this is not all; the gas-holder is comparatively permanent; the accumulators require frequent renewals and repairs; the gas-holder gives back all the energy put into it; the accumulators waste at least 20 per cent.; the gas holder may be emptied as fast as you please; the accumulators, not faster than a certain rate without diminishing their capacity. Taking all into consideration, the cost of storing energy by the aid of accumulators, and storing it in a gas-holder are quantities of a different order of magnitude. If no gas-holders were used, and all the gas had to be made just as it was wanted, its cost for lighting would be several fold what it now is, even if gas producers could be found capable of instantly varying the supply as the demand varies. The gas-producing plant would have to be enormously increased; so would the size of the mains, and so would the wages of labour. If electric power could be stored as cheaply as gas, there would soon be little hope that the gas companies would maintain their dividends.

Let us see from a financial point of view whether accumulators can be used economically for storing up electrical power continuously produced during the 24 hours, and used rapidly for a short time.

Assume that the whole of the plant with the accumulators is capable of supplying 40,000 lights for ten hours continuously, and that during that time half the power is supplied from the accumulators. Ten hours in the twenty-four hours is not an unreasonable allowance, for we have melancholy experience in London of continuous fog for days, and this would tax the plant we are considering to the utmost. We are to be ready then any time on short notice to supply 40,000 lights, and to continue to supply them for ten hours. Compare the cost, firstly, of maintaining this state of readiness with the accumulators and with a plant without accumulators. We shall require a battery capable of giving 1,250 units for ten hours; such a battery costs not less than £50 per unit, or in all £62,500. To maintain it will cost from 10 to 15 per cent. on the cost; there will also be interest on the outlay and amortisation, say in all 20 per cent. or £12,500 a year. If we assume that the batteries are distributed at the various points of the system of conductors, we may also assume that the charges for land and buildings will be much the same as for the plant without accumulators. The boilers, engines and dynamos will be just one-half. The switchboard and instruments will be much the same. But the conductors will be reduced, smaller or shorter feeders being necessary, probably £40,000 will go as far with accumulators as £50,000 without. The coal bill may be dispensed with entirely, as we may assume that steam could always be got up during the time in which the demand increased from nothing to one half of the maximum, and that therefore all the coal burned can be assumed to be burned for producing current. That is to say, we assume the quantity of coal burned is proportional to the quantity of electric energy, and that therefore when no electricity is actually used, no coal will be burned. The wages may be reduced, for we have only to be ready to run half the plant, and a small wage will suffice for attendance on the accumulators. The wages of linesmen and the like will remain the same. Assume the total wages to be £3,500 instead of £5,000. The account will then stand thus:—

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines...	1,080
Dynamos	675
Switchboard	300
Conductors	6,000
Wages	3,500
	£28,105

practically the same result as we obtained before.

Now consider another hypothetical case, which of course can never occur in practice. We are to supply 40,000 lamps for 10 hours every day with the plant just described, charging the accumulators during 12½ of the 14 hours during which the light is not required, 12½ hours' charging giving 10 hours' discharge of the same energy. The coal would cost the half of £30,000 if the machinery had to run the whole of the 24 hours. It has to run 22½ hours, but the boilers have to be kept warm the whole time, hence the coal will cost the half of £6,000 for keeping the boilers warm, and $\frac{22\frac{1}{2}}{24}$ of the half of £24,000 for generating steam. The wages may fairly be taken as £4,750, and the account will stand:

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,800
Dynamos	1,125
Switchboard	300
Conductors	6,000
Wages	4,750
Coal	14,250
Stores	1,425
	£46,200

The cost of supply for the same 10 hours without accumulators would be as follows:—

Land	£1,000
Buildings	1,500
Rates	500
Boilers	2,100
Switchboard and Conductors ...	7,800
Engines	2,760
Dynamos	1,725
Coal	16,000
Stores	1,600
Wages	6,000
	£40,985

a cost of about 11 per cent. less than where accumulators are used.

Putting it another way, the cost of being ready to supply and to continue to supply, is about the same whether accumulators are used or not; the additional cost of actually supplying current is about 40 per cent. more where accumulators are used than where they are not used. It may be safely inferred that the use of accumulators does not seriously alter the conclusions I have drawn as to the proper method of charging consumers for a supply of electricity.

The question of whether the great cost of a supply for short hours can be removed by the use of accumulators, may be looked at in another way. Will it pay a consumer to put in his own accumulators and charge them from the station supply? We may reasonably suppose the undertaker will remit the fixed charge in consideration of the consumer only taking his current at slack times. His accumulators, if they are to be of capacity to maintain his supply through a foggy day, will cost him £50 per unit per hour (or per kilowatt) and the annual charge in respect of them will be £10 per year, to which, if we add a rent for the space the battery occupies, gives us a charge not differing materially from the fixed charge made or suitable to be made by the undertaker. But in order to obtain 2d. worth of electricity he must purchase 2½d. worth for charging his battery.

A word or two more about the use of accumulators. These have certainly improved, and they will continue to improve. They will become more durable and more economical of power in working, and their first cost will become less. An inspection of my tables of cost shows that a very little improvement would render them valuable even in very large stations for the mere purpose of diminishing the machinery required, by storing the energy developed at slack times to be used in busy times. The certainty of improvements in accumulators, and the possibility that the improvement may be considerable, is a strong argument for the use of the direct current, wherever it is not precluded by the distance of transmission being too great.

It will be noted that I have assumed a very large station. Accumulators have another use which greatly increases their advantage in smaller stations. There are many hours in the twenty-four when it is absolutely certain that the demand will be small. If accumulators are used the attendance of the staff may be dispensed with during those hours, and a considerable sum in wages will be saved. The proportion of wages to the whole of the charges is much greater in small stations than in large. In most small stations giving continuous supply, accumulators ought to be used notwithstanding their expenses and defects, and I believe the day is not far distant when they ought to be used in connection with most large stations also.

If instead of a continuous current, an alternating current with transformers is used, the modification in the account will be that the cost of conductors will be diminished, but the cost of transformers will have to be added. If the distances are small, the increased cost of transformers will exceed the saving in the conductors; if the distances are considerable, the cost of transformers will be less than the saving of conductors. In both cases the general character of the result will be the same as before, the cost of being prepared to give a supply will be considerable, and the cost of actually giving the supply will be much smaller than is generally supposed. Indeed, with the alternating current this peculiarity will be even more marked, for the machinery has not only to be kept in motion, however small the consumption may be, but a certain current must be maintained in every transformer. With the best transformers, this current may only have an energy 1½ per cent. of the energy of the current when the transformer is fully loaded. This would increase the coal bill in the case considered by about £500 per year, whether the supply was used or not.

It is possible, indeed probable, that some of my assumed figures may be shown to be too high or too low for the generality of cases. It is of no moment; let each one take any figures he pleases, within reason; let him assume that the supply of electricity is made by any system he pleases; he will arrive at a result broadly similar to mine. To be ready to supply a customer with electricity at any moment he wants it, will cost those giving the supply not much less than £11 per annum for every kilowatt, that is for every unit per hour, which the customer can take, if he wishes, and afterwards to actually give the supply, will not cost very much more than ½d per unit. This is the point I have been labouring to impress, for I take it, it is essential to the commercial success of electric supply. It is hopeless for electricity to compete with gas in this country all along the line, if price is the only consideration. But with selected customers, electricity is cheaper than gas. Surely it is the interest of those who supply electricity to secure such customers by charging them a rate having some sort of relation to the cost of supplying them.

REVIEWS.

Lightning Conductors and Lightning Guards: A treatise on the protection of buildings, of telegraph instruments and submarine cables, and of electric instruments generally, from damage by atmospheric discharges. By OLIVER J. LODGE, D.Sc., F.R.S., LL.D., M.I.E.E. Whittaker and Co., 2, White Hart Street, Paternoster Square.

This book is the outcome of two lectures delivered before the Society of Arts in 1888. The first seven chapters are taken up chiefly with a general review of what has hitherto been done with reference to lightning conductors, and the weak points in the general arguments which are used to indicate how a conductor should be constructed are vigorously attacked. Dr. Lodge's well known experiments illustrating his own theories on the subject are, of course, given at length, together with the mathematical principles upon which they depend; but, interesting as all this is, it is to the practical deductions that one looks with the greatest eagerness. The suggested practical rules are given in Chapter XVIII., and on reading carefully through them, one is struck, not with their originality, but with their very close resemblance to generally accepted rules. It is only here and there that we come across a suggestion which bears the impress of originality, such, for example, as statement 65, "It is not wise to erect very tall pointed rods above the roof of a building." What 71, viz.: "In chimneys it may be well to use insulators to protect the bricks from concussion" means, is not at all clear. Dr. Lodge, as the result of his interesting investigations, has done a little to unsettle general opinion, but nothing to set it right. Why do we not have given us, as an example, a drawing of a house or other building, as protected by existing rules, and also a drawing of the same edifice with protectors arranged according to Dr. Lodge's views; or a drawing of an edifice which has actually been struck and damaged by lightning, though protected (?) by approved forms of lightning conductors, and also a sketch showing how Dr. Lodge would have prevented the damage from having been done.

With regard to protectors for telegraphic circuits, in which the author has carried into practice his views, Dr. Lodge heads his pages descriptive of his conclusions "failure of *all* present guards." This is rather a strong statement in view of the author's limited experience. That the improved guards are likely to prove very efficient, there seems little doubt; unfortunately, however, it will be a matter of years to show their real value, *i.e.*, that they are really in practice more efficient than those which are in general use. It could hardly be admitted that the new protectors are non-efficient, and therefore their adoption at the termination of submarine cables would seem very advisable, but beyond this one would scarcely be prepared to go.

The Practical Management of Dynamos and Motors. By FRANCIS B. CROCKER, and SCHUYLER S. WHEELER, D.Sc. Published by the D. Van Nostrand Company, New York; and E. & F. N. Spon, London, 1892.

The joint authors of this little book are well known in the electrical circles of the United States, and the practical manner in which they have dealt with the task they have undertaken shows a close acquaintance with dynamo and motor details, both in construction and in use. But the excellent matter is marred by want of style and looseness of expression. For instance, torque is invariably confounded with the pull on the periphery of an armature; and on page 51, and elsewhere, the *torque* is expressed as $\frac{\text{H.P. } 33{,}000}{2\pi R S}$, where R is the *radius* of the prony brake lever and S the speed in revolutions. It is almost unnecessary to state that this expression gives simply the load on the brake arm in pounds; and that the *torque* is by definition referred to unit radius. Such a mistake is due to carelessness, and yet one of the authors is a D.Sc., and both are vice-presidents of the American Institution of Electrical Engineers. On page 49, too, occurs the lucid statement: "Much force usually means that *something wrong is being done or in a wrong way.*" (The italics are ours.)

This book is obviously written for workmen, and therefore it is of double importance to be not only careful as to the definitions but also as to the language in which they are couched. In the preface to the book it is stated that the contents appeared as a series of articles in the *Electrical Engineer*, of New York, and that the object is to give simple directions for practice. And the authors conclude by saying that "the present volume is simply the groundwork of a larger and more elaborate treatment of the subject which they contemplate preparing, and they will appreciate any suggestions." Hence our criticism.

This preliminary instalment comprises about 100 pages, and is divided into two heads; the first dealing with general principles and practical hints as to the running of dynamos and motors, while the second is devoted to the "localisation and remedy of troubles." From a practical point of view the arrangement of the matter is admirable. The instructions deal with almost every contingency, and the diagrams are first-rate.

The whole needs careful revision, but its utility will be sadly diminished if the new book be too bulky for ready reference by the dynamo-tender and the lineman.

Die Accumulatoren. By JOHANNES ZACHARIAS. Jena: Hermann Costenoble.

This book treats of the "construction, use and management of secondary batteries," and the author refers those who desire a complete knowledge of the historical developments of secondary batteries to Dr. Hoppe's writings. Mr. Zacharias nevertheless devotes sufficient space to the general theory of polarisation, and in particular to the recent researches and observations of Farbaky and Scheneck, Ayrton, Lamb and Smith, Strecker and Jahr. The author next describes and illustrates various types of accumulators, and goes into the details of the construction of plates, cells, insulators and separators; he also touches upon the arrangements of an accumulator factory. Here we find Continental practice brought up to date, but of the latest English types and methods little or no mention is made. On the other hand Mr. Zacharias gives a complete translation of the long series of articles on accumulators which appeared a few years ago in the ELECTRICAL REVIEW, under the name of Anthony Reckenzaun, and which the author considered of sufficient importance to be reproduced in full, since all the statements then made by Reckenzaun are still applicable to present day practice.

Chapter VII., dealing with the commercial results obtained in a number of central stations using accumulators is exceedingly interesting. Here we find the broad statement that it has been proved that in *no central station using accumulators has there ever occurred a discontinuance of light.* This statement evidently refers to German stations where accumulators are used to a very much larger extent than here. With regard to the *efficiency* of secondary batteries in a number of central stations, there are tables giving the charges and discharges in watt-hours for every month of the year. Taking the central station of Barmen, for instance, we find that during the year 1891 the mean efficiency of the battery was measured to be 70·22 per cent. Out of 57,048,952 watt-hours put in, 40,008,690 watt-hours appeared as useful energy outside the battery. In the case of the Dessau station the results are 27,503,698 watt-hours to 21,827,120 or an annual average of 79·37 per cent. At Hanover the energy efficiency for the year 1891 was 78·7 per cent. The worst efficiency recorded occurred in February, 1891, at Barmen with 56·85 per cent., whilst for March of the same year, 79·64 per cent. are registered. Five years' experience at Dessau, where large gas engines are used for driving dynamos, point, according to the author, to most satisfactory results.

The application of accumulators for the propulsion of cars and boats, and their use in telegraphy is fully considered. In Chapters VIII. and IX. various switchboards for accumulator installations are described, and Chapter X. contains practical directions for the erection of sets of batteries with their accessories. In Chapter XI. we find useful paragraphs on the testing of cells, chemically and electrically. The last chapter is purely speculative, dilating upon the future possibilities of secondary batteries.

The book is full of practical information, thoroughly well illustrated, but, unlike many modern German treatises, this is printed in German text which renders the reading rather difficult for English students.

OBITUARY.

WE greatly regret to have to announce the death of Mr. Edward Graves, Engineer-in-Chief of the British Postal Telegraph Department, which took place early on the morning of the 9th inst. Mr. Graves was born in February 1834, and was, therefore, in his 59th year when he died. After a brief period in the service of the North Eastern Railway Company, he first became connected with telegraphy in 1852, when he entered the service of the International Telegraph Company at York, under Mr. de Chesnel (for whom he acted during a prolonged illness of that gentleman); in 1856 he was appointed superintendent and district engineer of that company's East Coast of England and Scotland district, the latter extending from London to Aberdeen. At the transfer of the telegraphs to the State, in 1870, Mr. Graves removed to Birmingham, as Divisional Engineer, in charge of the North Western Postal Telegraph Division, and in 1878, on the retirement of Mr. R. S. Culley, he was appointed Engineer-in-Chief of the Post Office Telegraphs.

An able administrator and possessed of great financial acumen, Mr. Graves's ability was strikingly shown in the series of arbitration cases which were held in 1874-78, with reference to the compensation to be paid by the Post Office to the various railway companies for the loss of telegraph business, &c., consequent on the acquisition, under the Telegraphs Act of 1868, of the telegraph work and plant of the United Kingdom by the State. The success of his efforts on behalf of the Department were such as called for the warm commendations of Sir Richard Baggallay (the then Attorney General), and other eminent counsel.

Mr. Graves represented the Post Office as delegate at the Paris Electrical Conference in 1881, and received the cross of an Officer of the Legion of Honour from the French Government. He also served on the Channel Tunnel Defence Committee of 1882. More recently he acted as one of the Board of Trade Committee on Electrical Standards, and formed one of the existing Royal Commission of enquiry into the subject of telegraphic communication with lighthouses and lightships.

Mr. Graves was President (in 1888) and Honorary Treasurer of the Institution of Electrical Engineers.

Not only as an able and impartial adminstrator, but also as a greatly respected chief, Mr. Graves will be much missed by all members of his staff, with whom his relations were most cordial.

We are requested to state that the funeral will take place to-morrow, noon, at Hammersmith Cemetery.

The announcement of the death, on Wednesday last, of the Duke of Marlborough, has been received with feelings of great surprise as well as of deep regret. It is unnecessary to repeat here the various points in his general career, but of late years he has rendered much assistance in the development of electrical and telephonic enterprise. The late Duke was chairman of the Brush Electrical Engineering Company, and director of the New Telephone Company and the City of London Electric Lighting Company, as well as being chairman of the Electric and General Investment Trust. The part which the Duke of Marlborough always took in regard to the telephonic matters of the country and his speeches before the London Chamber of Commerce and the House of Lords, as well as his letters which appeared in the columns of the *Times*, will long be remembered. His sudden death is thought to have been caused by heart disease. He was only in his 48th year.

Engineering Features of the Houses of Parliament.—The issue of *Industries* for last Friday contains information of somewhat exceptional interest to those connected with the engineering industries, as well as to the general public. The subject is one for which, for the purpose of properly describing and illustrating the different arrangements, it was found necessary to publish a special enlarged number. There is a profusely illustrated technical description of the ventilating, heating, lighting, and drainage arrangements of the Houses of Parliament. The illustrations, we understand, have been specially drawn for this number by an experienced technical artist, and great care has been taken to make the account of the technical arrangements made within the Houses of Parliament both comprehensive and accurate.

NOTES.

Wokingham Lighting.—At the meeting of the Wokingham Town Council, held last week, it was resolved "That a committee of five members of the council be appointed to consider the question of acquiring gas works under the control of the corporation, or the best means of lighting the town, and to report to the council at a future date." The clause, "or the best means, &c.," was inserted after several members had referred to the adoption of electric lighting.

Electric Railway at Barry.—A meeting of the directors of the Barry Railway Company was held last week, the proceedings, as usual, being private. Upon enquiry at the close of the meeting, a representative of the *Western Mail* was informed by Mr. Richard Evans, the general manager of the company, that the only information which he was at liberty to communicate to the press was the fact that the report of a directoral committee with reference to the construction of an electric railway from Barry Town to Barry Island was received and adopted, and it is understood that steps will be taken to carry out the work immediately.

Elmore's American Company.—A few days ago, a shareholder in "Elmore's American and Canadian Patent Copper Depositing Company, Limited," wrote to the *Financial News*, giving a copy of a letter he had written to the secretary of that company on 4th inst., which reads as follows:—"I have received your circular of October 31st. You gave me to understand that it would be satisfactory, and would show me that the company was far from a failure. It is far from satisfactory, and quite in keeping with everything connected with the Elmore's Patent Companies. You start a company to introduce your patents in America and Canada; you draw the shareholders' money—which is being wasted—and then you find out, what you should have ascertained before, that the time is not favourable for the introduction of your patents; nor in 'until intending purchasers in America can see the process working on a large manufacturing scale at the works of the Elmore companies in Europe,' which, translated into plain English, means indefinite postponement. The admission that the objects undertaken by the company, as set forth in the prospectus, have been a failure, should determine the directors to return to the shareholders their subscription in full. Unless this is done, I shall take legal advice on my position, and act as I may be advised."

New York-Chicago Telephone Line.—Thoroughly delightful, says the New York *Electrical Engineer*, was the reception awaiting those favoured with the American Telegraph and Telephone Company's invitation to attend the formal opening of the new telephone line between this city and Chicago, on October 18th. Forty-two receivers were placed about the room, and the guests listened to music, recitations, and conversations. Mr. John E. Hudson, President of the American Bell Telephone Company, and of the Long-Distance Company, then introduced Mayor Grant, who held a short conversation with Mayor Washburn, of Chicago, after which Prof. Alexander Graham Bell conversed with Mr. William H. Hubbard, who was at the Chicago end of the line. Notwithstanding the fact that 42 receivers were included in the circuit, the articulation was perfectly clear and distinct, thus demonstrating the power of the transmitters and the admirable proportions and arrangement of the line circuit. The New York-Chicago line is 950 miles in length, and is constructed in the most substantial manner. The poles are of cedar and chestnut, 35 feet and upwards in length, and average about 45 in number per mile, making the total number of poles 42,750. To determine the feasibility of transmitting speech over the heretofore unapproached distance of nearly 1,000 miles, a special experimental circuit, consisting of two No. 8 hard-drawn copper wires, has been constructed. This wire weighs 435 lbs. to the mile, and the circuit contains 826,500 lbs. of copper. A circuit of the size generally used for telephone service would weigh less than 200,000 lbs. The use of cables, which are so detrimental to long-distance telephone transmission, has been avoided to the utmost possible extent, and they are used in the line only at the terminals and at the river crossings in the immediate vicinity of New York. Prior to the construction of this line, the limit of successful transmission did not exceed 500 miles. The line is now open for regular business.

Theatre Electric Lighting.—We cull the following from the *Sheffield Telegraph*:—"The utility of the electric light in theatres was strikingly demonstrated at the Criterion the other night. During the performance a globe of one of the cluster of incandescent lamps that light the theatre from the centre of the ceiling cracked with a sharp report, heard all over the house, and the fragments of glass dropped in the stalls with a silvery splash. The light of that particular lamp, of course, went out, and there was not the slightest alarm or excitement. The only notice taken was a facetious inquiry from the gallery, 'Why don't yer pick up the pieces?' Would a gas accident have been as free from panic?"

Primary Battery Improvements.—We have been requested by Mr. J. Russell Grant to publish the following report on a new exciting paste for primary batteries:—

22, Paternoster Row, London,
November 3rd, 1892.

J. Russell Grant, 24, Bouverie Street,
Fleet Street, E.C.

Dear Sir,—We have the pleasure to report the results of our tests of the battery exciting pastes which you handed to us for experiment.

Three descriptions of paste were tried, two of these being new compositions, which you designate "Crowley's Electric Paste," and the third the ordinary bichromate mixture commonly used in bichromate batteries.

Two ounces exactly of each paste were placed in three similar Grenet bottle cells with the necessary quantity of water, and the cells were allowed to remain idle (with the zincs raised) for about 12 hours.

Each cell was then in succession set working through an ammeter, the current being adjusted by means of resistances, so that in each case the current commenced at ·5 ampères.

The following are the results of the runs:—

No. 1 cell (dark coloured paste).		No. 2 cell (light coloured paste).		No. 3 cell (ordinary bichromate paste).	
Time.	Current ampères.	Time.	Current ampères.	Time.	Current ampères.
10·30	·500	10·30	·500	10·30	·500
1·30	·475	1·30	·460	12·30	·200
4·30	·300	4·30	·300	...	...
6·0	·200	6·0	·200	...	...

It will thus be seen that whereas Nos. 1 and 2 cells with Crowley's paste gave in the same period (7½ hours) approximately the same rendering, No. 1 cell being slightly the best, No. 3 cell with the ordinary bichromate mixture ran down to the same extent in a period of two hours only. The tests, therefore, distinctly show that the new pastes are, for purposes where bichromate batteries of the ordinary description would be used, very far superior to the ordinary bichromate mixture.—Yours faithfully,

H. Alabaster, Gatehouse & Co.

The Electric Light at Kingswood.—At a meeting of the Kingswood (Bristol) Local Board, last week, the solicitor to the authority conferred with the members as to what course should be taken to ensure the better lighting of the district. The transfer of Messrs. Parfitt's business to the Western Counties Company would not, Mr. Sibly stated, affect the agreement between the board and the company. He considered the agreement a very fair one, and advised the board to enforce the penalty clauses. The firm had told the board they would work the system so as to give them a good light, and the board ought to have the light or the penalties should be enforced. The system was new, and doubtless, although the firm did their best, they might not be able to get the light perfect. He thought the board should bear with the firm as far as they could.

Old Students' Association—The seventh annual dinner took place at the Holborn Restaurant on October 28th, and was attended by upwards of 60 members and friends. Among the guests were Mr. H. C. Saunders, Q.C., Mr. Reginald Saunders, Mr. Soper, Prof. and Mrs. Ayrton and Mr. A. P. Trotter, letters of regret being received from Mr. Preece and Mr. F. H. Webb. Dr. Thompson was unavoidably absent through illness, and Prof. Perry was also detained by his special lectures. Mr. Mordey, member, proposed the toast of "The City and Guilds of London Institute," to which Prof. Ayrton responded in a humorous speech. Mr. H. C. Saunders proposed the "O. S. A.," to which Mr. Ll. B. Atkinson, as president elect, responded. The report was read, announcing the election of 64 new members during the past year, and stating that the cash account showed a credit balance. Excellent music was discoursed by Messrs. Emerson (pianoforte), Fitzgerald (vocalist), and Jacoby (violin). A most enjoyable evening was spent, and the meeting broke up towards the small hours.

Manchester Association of Engineers.—The third meeting of the thirty-seventh Discussion Session of this Association is to be held on Saturday, 12th inst., at the Grand Hotel, when Mr. B. H. Thwaite, C.E., F.C.S., of Liverpool and London, will read a paper on "Economic Possibilities of the Generation of Electromotive Force in the Coal Fields and its Application to Industrial Centres." The following is a synopsis of the paper:—1. Introduction draws a parallel between the transmission of natural electrical force, developing organic life movement, and the later development—the electric applications prompted by man. 2. The evolution of the electro-technical industry and science. 3. The importance of the application of electric energy in promoting new industries, instanced by the example of the Swiss electro fusion, electrolytic and power electric transmission, installations. 4. The importance and duty of employing methods of high efficiency and economy in the utilisation of our fuel resources. 5. Arguments advanced in support of central power generating stations. 6. The financial, industrial, hygienic, thermo-dynamic, thermo-luminous efficiencies and economies, and agricultural and floricultural advantages of the transmission and distribution of electromotive force. 7. Efficiency comparison between different kinds of thermo-dynamic motors, and the value of large powers in promoting economy, is set forth. 8. The efficiencies of belting, shafting, and electric methods of internal transmission of power compared. 9. The financial risk involved in the copper electric conductor mains is determined calculably and graphically, and is compared with high-class securities. 10. The chronological development of electro-dynamic transmission methods, and the results of the Lauffen-Frankfort transmission project is given tabularly and graphically. 11. Three projects of electrical transmission of energy generated in the coal fields are described:—The first for supplying the Lancashire centres of industry, and the area adjoining the Ship Canal; the second for supplying the Yorkshire centres of industry; the third for supplying the centres of industry of the Midlands and the Metropolis. 12. The specifications of the Metropolitan electric transmission project are set forth in detail. Besides numerous graphic diagrams, the paper will be illustrated by lantern diagrams and figures, pertinent to the subject.

Elmore's Patent Copper Depositing Company.—A circular has been issued to the shareholders announcing that the accounts for the past year are in course of preparation. As the "past year" ended in June last, it would seem that no particular hurry has been taken over the course of preparation. It is hardly conceivable that the shareholders will be satisfied with the further information that the tubes are "most satisfactory," and that at the next meeting they will be shown some specimens of pans and "similar objects" of complicated construction which are expensive to manufacture by existing processes. If the shareholders are disposed to be properly impressed with such an exhibition, they may find that such pans are also expensive "objects" for Elmore shareholders. There have been exhibitions of a similar nature at previous meetings, when the shareholders have been sent empty away, except as to promises, of which, indeed, they have had their fill. The circular, however, does nothing to show that the promises are nearer fulfilment, beyond the absurd assertion that "the success of the commercial and financial future" may be said to be secured, because three directors have retired, and two others have been elected in their place. The two new directors "are throwing themselves with energy into the development of the Elmore business after having thoroughly satisfied themselves," &c. It is noticeable that the development of the Elmore business uses up considerable energy, so that the rectification of mistakes necessitates new managers, and re-organisation leads to new directors, and notwithstanding the number of eminent and able persons who "satisfy themselves," &c., the shareholders are no nearer seeing any tangible return for their money than ever they were. The long suffering nature of the shareholders is one of the remarkable features of Elmore finance. The new directors have our sympathy, but we hope that their appointment, their holdings, and their satisfaction at the outlook will not prevent the shareholders making the strictest investigation into the condition of their affairs, and comparing the present position with that which they were told with the greatest confidence might be expected.

The Electric Light at Lewes.—The East Sussex County Council have had under consideration a report from the County Hall Committee. A sub-committee on electric lighting, having held a consultation with a deputation of the Lewes Town Council, recommended that, in the event of the latter body establishing an electric light station, or deciding to hand their powers over to a public company to be formed for that purpose, the East Sussex County Council should agree to take from them the electric current necessary to light the County Hall buildings at a cost of 8d. per Board of Trade unit, and that the requisite fittings for the light should be provided for the purpose, at a cost to be ascertained before finally deciding the question. The committee recommended the council to adopt the recommendation of the sub-committee, provided that the council authorised the committee to incur the necessary expenses of fittings, a sum not exceeding £200 being the estimated cost. After a discussion the report was adopted, with the addition, after the words, "At a cost of 8d.," of the words, "for one year, and afterwards subject to discount of 25 per cent."

Yarmouth Electric Lighting.—Mr. W. H. Preece has drawn up a report on the electric lighting question at Yarmouth. The matter has been thoroughly thrashed out by the Special Committee, who in their recommendation said that a number of tenders received showed that an electric lighting installation of 4,500 lamps of 8 candle-power could be provided at a cost somewhat under £10,000, and this being the smallest instalment which Mr. Preece advised, that the Council should apply to the Local Government Board for power to borrow £10,000, the actual details of the scheme to be adopted to be subject to future consideration. The matter is to be dealt with in committee, consisting of the whole council, and Mr. Preece is to be asked to be in attendance.

Electric Lighting of Fifth Avenue, New York.—In the New York *Electrical Engineer*, an article appears from the pen of Mr. Jos. Wetzler, treating of the illumination of New York on the occasion of the recent Columbus celebration, more especially the lighting of the Fifth Avenue, where a special feature in regard to the arc lamps is noticeable. The most interesting point in the new system is the employment, instead of a *single* arc lamp, of a *pair* of arc lamps on one post, each lamp taking five ampères at the usual arc-lamp voltage, approximating 50 volts. The same amount of energy is used as in a single arc lamp on a high tension in series circuit, but it has the double advantage of permitting connection with the Edison mains through the ordinary house service, without running any special circuit or connecting wire from post to post, and of giving a more effective light, of better diffusion, so that absolutely no shadows are cast, thus avoiding a chief objection to the ordinary street arc lighting.

Society of Arts.—The first meeting of the 139th session of the Society will be held on Wednesday, November 16th, when the opening address will be delivered by Sir Richard Webster, Q.C., M.P., Chairman of the Council. Mr. James Dredge will read a paper on "The Chicago Exhibition, 1893," on December 7th. At subsequent meetings, the dates of which are not yet published, a paper will be read by Prof. George Forbes, F.R.S., on "The Utilisation of Niagara." The Cantor Lectures on the evenings of January 30th, February 6th, 13th and 20th, will be by Dr. J. A. Fleming, on "The Practical Measurement of Alternating Electric Currents;" and a special course of six lectures, under the Howard Bequest, will be delivered by Prof. W. Cawthorne Unwin, F.R.S., on "The Development and Transmission of Power from Central Stations," January 13th, 20th, 27th; February 3rd, 10th, 17th.

Merthyr and Electric Lighting.—Mr. W. H. Massey recently reported on the proposed electric lighting of Merthyr, but it has been decided to defer the matter for twelve months; in the meantime, the committee are to visit other towns lighted by electricity for the purpose of obtaining full information.

East Molesey and Electric Lighting.—The East Molesey Local Board have formed a committee to consider the electric lighting question for their town.

A Note for the Gas Companies.—A question came before the Carlow Quarter Sessions the decision on which, says the *Freeman's Journal*, will be read with interest in Dublin just now. The town of Carlow was the first in Ireland to be lighted by electricity, and recently several householders have substituted that illuminant for gas in the lighting of their houses. Many, however, hold on to the meters, so as to be able to fall back upon the gas in case of a failure in the electric supply. At the last sessions the gas company brought an action against such a householder to compel him to give up the meter, as it was the property of the company. The County Court judge, without deciding the question that had been raised as to the right or wrong of the company refusing gas to the private consumer when he pays for what the meter registers, dismissed the case on the ground that the company had no right to remove the meter until they had first cut off the connection with their mains.

Paisley and Electric Lighting.—At a meeting of the Paisley Town Council, last week, a report was brought up from the Lighting Committee. In the report it was stated that the Electric Lighting Committee had not seen their way to recommend the Council to proceed with the laying down of an installation for the lighting of the town under the order obtained last year, the probable demand for the light not being sufficient to warrant the expenditure involved. It was remitted to the Electric Lighting Company to further consider and report.

Fire.—On Wednesday last week, a fire was discovered in the electric light engine room adjoining Crown Lea, the residence of Mr. Neville, near Malvern. The fire was soon got under, but not before considerable damage was done. The house is lighted with electric light, and the working of the engine is superintended by Mr. Neville. It is not known how the fire originated.

Wolverhampton Electric Lighting.—The Wolverhampton Town Council General Purposes Committee have under consideration the question of raising certain capital for various purposes, one of which is electric lighting.

The Burnley Corporation and Electric Lighting.—At a meeting of the Burnley Town Council on Wednesday, the following contracts in connection with the electric lighting scheme were accepted:—Callender's Bitumen Telegraph and Waterproof Company, London, for cables, of £4,537; Electric Construction Corporation, Limited, Wolverhampton, for dynamos, accumulators and switchboards, of £2,056; and the Burnley Ironworks Company for engines, of £16,007.

The Cost of Electric Supply.—A perusal of Dr. John Hopkinson's Presidential address to the members of the Junior Engineering Society, which we publish this week, will afford food for thought to advocates of both gas and electric lighting. The allusions to flat flame burners, to accumulators, to alternating current machinery, and his comparison of the price of electricity with 16-candle gas, are all open to criticism, and we hope that the subject may be vigorously taken up.

The Electric Lighting of Stafford Municipal Buildings.—At a meeting of the Stafford County Council last week, it was stated that a communication from the County Council intimated that they had under consideration the question of introducing the electric light to the new county buildings, and asked what facilities the council could offer in the matter. On the motion of Alderman W. H. Peach, the letter was referred to the Electric Lighting Committee.

Electric Lighting of Fareham.—The directors of the Fareham Electric Lighting Company have given notice to their customers that from the 1st of the present month they will supply the light by meter only, at a fixed rate of 8d. per unit.

Electric Light for Bandon.—It is stated that a company will shortly be formed with a view to provide the electric light for the town of Bandon.

Preparations at Bristol.—At a meeting of the Bristol Town Council, on Wednesday, the Electrical Committee reported that they were about to contract for the laying of electric mains in those streets which the committee had resolved to light by electricity.

NEW COMPANIES REGISTERED.

Julius Sax & Company, Limited.—Capital £20,000, divided into 2,000 shares of £10 each. Objects: To acquire the businesses of Julius Sax & Co., carried on by Messrs. Alf. and Chas. W. Sax, and the lands, factories, warehouses, and effects connected therewith; to carry on the business supplying electricity in all its branches, and to construct, lay down, establish, fix and carry out all necessary cables, wires, lines, accumulators, lamps, works, and to generate, accumulate, distribute, and supply electricity, &c. The subscribers (with 1 share each) are: J. Martin, Woodford, gentleman; A. G. Hales, Tottenham, clerk; F. Blackhall, Tottenham, gentleman; Chas. Kück, Henslowe Road; W. E. Higgins, Tower Hamlets Road, clerk; F. W. Ward, Trinity Square, S.E., clerk; Edwin F. Young, Lewisham. The number of directors is not to be less than two nor more than five. Qualification, £1,000 debentures; remuneration, any sum not exceeding £500. Registered on the 28th ult. by W. B. Styer, 2, Threadneedle Street, E.C.

The Alkali Syndicate, Limited.—Capital £20,000 divided into 4,000 shares of £5 each. Objects: To carry on the business of manufacturers of alkalies and of the plant, machinery and materials therefor, either as principals or agents, especially in relation to dealing with inventions and letters patent therefor, or rights therein. To carry on business as civil, mechanical and electrical engineers, or any other business in connection with any inventions or processes in which the company may be interested. The subscribers (with one share each) are C. P. Thompson, 92, Foulden Road, West Hackney, Middlesex, secretary; F. C. Hancock, 7, Smith Square, Westminster, Middlesex; J. Burchall, Woodside Lane, North Finchley, N., solicitor's clerk; W. Stewart Gayton, Kingston Hill, Putney, bankers' clerk; T. R. Rollinson, 28, Vernon Street, West Kennington, Middlesex; H. C. Hannington, Farringdon Street, E.C., druggists' accountant; W. M. Whitford, 120, Newgate Street, E.C., tobacconist. The number of directors is not to be more than seven nor less than three, exclusive of a managing director. The directors must be shareholders in the company to the extent of £500 in ordinary shares. Remuneration £150 per annum for each director, and £100 per annum as an additional sum for the chairman. Registered on the 26th ult. by H. J. Budd, 8, Queen's Buildings, Southwark, Surrey, law stationer.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belgium.—Date not stated. For the supply of distance signals, and accessories thereto, for the Belgian State Railways. Particulars from the director of Belgian State Railways, Brussels.

Blackpool.—November 24th. Tenders are invited by the Blackpool Corporation for the installation of wires, switches, &c., for the electric lighting of the new Police Station Buildings, situate in Lower King Street and Albert Road. Plans, &c., may be obtained from the Borough Engineer, whose address, and also other information regarding tenders, may be found among our advertisements.

Bristol.—December 1st. The Bristol Urban Sanitary Authority invite tenders for the supply and erection of underground feeder mains, arc light circuits, junction house boxes, arc lamps, posts, and suspension gear. Particulars regarding form of tender, &c., will be found in our advertisment pages.

Cologne, Prussia.—November 15th. For the supply of 600 kilos. of copper wire, 40,000 kilos. of bar copper, 35,000 kilos. of edged copper plate, for the Prussian Royal Railways. Particulars from the Stores Department of the Royal Railways, at Cologne.

Derby.—November 14th. For the erection of engine and boiler house, and for accessories at the Central Electric Light Station, Derby (Contract No. 3), for the corporation. Particulars from Bramwell and Harris, 5, Great George Street, Westminster, S.W.

Dundee.—At the monthly meeting of the Directors of the Dundee Chambers of Commerce last week, further consideration was given to the plans for the electric lighting of the Reading Room and Merchants' Exchange, and the secretary was instructed to obtain estimates of the cost of installation.

Glasgow.—November 12th. For the supply of electric lamp irons for the Glasgow Police Commissioners. Particulars from Mr. Robert Hamilton, Inspector of Lighting, 52, College Street, Glasgow.

London.—November 15th. For the sale of 26 tons of gutta-percha, old India-rubber, cuttings, wire, &c., for the Postmaster-General. Particulars from C. E. Stuart, Controller of Stores, Telegraph Street, E.C.

Manorhamilton.—December 6th. For the supply of stores, instruments and materials for the Sligo, Leitrim, and Northern Counties Railway Company. Particulars from Mr. R. E. Davis, Lurganboy, Manorhamilton, Ireland.

Paris.—November 16th. For the supply of enunciators for the telephone offices for the Direction Générale des Postes et des Télégraphes de France. Particulars from 103, Rue de Grenelle, Paris.

Paris.—November 17th. For the supply of 200 tons of bronze wire of high electrical conductivity, and 65,000 joints, in five lots, for the Director-General of Telegraphs, 103, Rue de Grenelle, Paris.

The Hague.—November 18th. For the supply of zinc, copper, &c., for the Dutch Navigation Ministry. Particulars from the Navigation Offices, Le Hague, Holland.

CLOSED.

Belfast.—Messrs D. & G. Graham, 140, Douglas Street, Belfast, have just secured the contract, from among 31 tenders, for the electric lighting of the Central Hotel, corner of Royal Avenue and Berry Street, Belfast. The installation is to consist of 576 16-candle-power incandescent lamps, and several arc lamps, with two dynamos, each capable of maintaining, if necessary, the whole number of lights. A fair share of wiring contracts is also in Messrs. Graham's hands in connection with the corporation supply of electricity.

Derby.—The Electric Lighting Committee of the Derby Town Council report that they have accepted the tender of Messrs. Siemens Bros. & Co. at £10,781 for providing, delivering, fixing, testing, setting to work, and maintaining combined steam engines, alternating and constant current dynamos, condensers and other machinery and apparatus for the production of electric light in that portion of the Borough to which the provisional order applies.

BUSINESS NOTICES, &c.

The Electric Light in the West End.—Since our last report we find that a large amount of new work is being carried out. Messrs. Vaughan & Brown, of Kirby Street, E.C., are fitting up the well known premises of the Polytechnic Institution, in Regent Street, W.—Messrs. B. Verity & Co. are at work at 12, Portland Place.—The Brush Electrical Engineering Company are working at 12, Upper Wimpole Street.—Electric lighting work has also recently been completed in the premises of Messrs. Long & Co., 7, Paddington Street.—At 29, Gloucester Place the Planet Electrical Engineering Company are carrying out fitting-up work.—Messrs. B. Verity & Co. are wiring the premises situate at 33, Great Cumberland Place. Further west we note that a contract is being carried out at 7, Craven Hill by Messrs. F. & C. Osler, while at 18, Craven Hill Mr. A. W. Sclater, of Oxford Street, is busy.—Messrs. Rashleigh Phipps and Dawson are at work at 4, Porchester Gate, while Messrs. F. Suter and Co. are installing some new premises at 9, Bayswater Hill.—Messrs. B. Verity & Co. are putting up fittings at 4, Notting Hill Terrace.—A contract has also recently been completed in the premises of Mr. Hammond, 151, High Street, Notting Hill.—Several other jobs have recently been completed in the Notting Hill district, a number by the local firm of Messrs. Money & Nash, of 19, Palace Garden Mansions, Notting Hill.—Messrs. Dawson, Hammond & Co., of Brown's Court, Edgware Road, W., are at present carrying out the electric lighting of the Home and Colonial Stores' premises in Edgware Road. The installation consists of 700 16-candle-power lamps, and is being executed under the supervision of Mr. Dawson, who, we understand, was chief engineer for ten years at Messrs. Whiteley's, of Westbourne Grove.

Caution.—Some weeks ago we gave in these columns a warning to manufacturers regarding certain firms on the Continent ordering goods without the intention of paying for them. The Netherlands Vice-Consul at Manchester, a few days ago, sent a letter to the *Manchester Courier* in reference to the matter, and we reproduce the same without any further comment:—"I shall feel obliged if you will, for the protection of the trading community, insert in your next issue the following warning, emanating from the Chief Constable of Amsterdam:—In consequence of the many complaints received from defrauded firms in this and other towns of Holland, the Chief Constable of Police in Amsterdam requests the manufacturers and merchants, who have lately had applications from the undermentioned persons, to send all letters containing such applications and orders to the head office of police (detective department) in Amsterdam, stating whether the goods applied for have been delivered or not. The following are the names:—Royal Import—Export Compagnie, C. or C. G. Demkes and J. Van der Berg, both at N. Amstel; Mevrouw de Wed. M. Zwartjes van den Berg and Zwartjes Böncker & Co. (alias Mevrouw Kwak Bönker); A. Oosterwerff; E. J. d'Hont (formerly of Rotterdam); J. van der Mark and Co.; Mevrouw van der Mark Renooy; Holle & Co., import-export, alias Mevrouw Winter Holle; J. F. L. Muller & Co., dealing in photographic articles; Douwe van der Kamp & Co.; H. F. Jansen & Co,, alias Jansen & Co., alias H. F. Jansons & Co.; Issers de Vries & Co., commissie en consignatie; Van der Meer & Co., alias Marie van der Meer & Co.; Den Bruggen & Co.; Wesselink & Co.; L. Beyers Cergen and Co.; L. Casteleyn & Co.; W. J. E. Havermans & Co.; Wienholdz and Dom, export-import.—DAVID S. BLES, Netherlands Vice-Consul."

The Electric Light in Putney.—Messrs. J. G. Statter and Co., of Victoria Street, Westminster, have the contract for fitting up an installation in the new residence, Wynnstay, now approaching completion on Putney Hill.

Artistic Electric Light Fittings.—In Messrs. Townshend and Co.'s list of novelties in art metal work, to which reference was made in our last number, illustrations are given of a number of fittings made in polished brass "Whangee," which is a patented speciality of this firm. Fig. 1 is a bracket in this style, but the

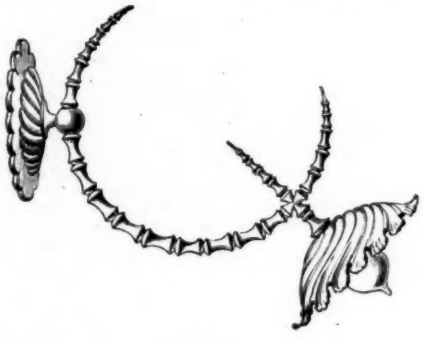


FIG. 1.

pleasing effect of the breaking up of the reflected light cannot be shown in a woodcut. Fig. 2 is a polished brass bracket of more

FIG. 2.

elaborate design, the modelling and finishing of which are excellent. Fig. 3 represents a polished brass electrolier, both fitting and lamps being suspended by silk cords. Messrs. Townshend & Co. have an established reputation for the production of magnificent floor lamps which they fit with a patent automatic telescope action which is free from friction and works without wheels or other mechanism. These are equally adapted for oil or electric lamps. A very handsome article is a novel arrangement consisting of a gold coloured stand

FIG. 3.

with shaped onyx table for a tea set, over which is a spirit lamp and kettle and above these an electric lamp under a large silk shade. To harmonise with white wood furniture, fittings are made in white and gold, the main structure of the fitting being of wrought iron covered with a permanent white enamel, and the ornaments of brass of a gold colour. Black wrought iron-work and brass is a well-known combination, but it is found that if the brass is made of a gold colour the effect is much more rich and satisfactory.

New Lists.—Messrs. W. H. Allen & Co., of Lambeth, have issued an illustrated price list of patent dynamos driven by belt, or directly by Allen's patent high-speed engines. There are a number of good illustrations contained in the catalogue, and detailed particulars are given of the "Kapp" dynamo, Allen's new patent direct-acting engine and dynamo, electric motors, continuous current dynamos. Steamship and yacht electric lighting are briefly dealt with, as are also search light plant, and the ventilating fan and electric motor. Altogether the pamphlet has been well prepared and printed.

A large number of price lists and catalogues are being brought out lately, more especially dealing with electric light wires and cables. The one now before us is that of W. T. Henley's Telegraph Works Company, Limited. Particulars, sizes, weights, and prices of vulcanised electric light cables naturally take more space in the catalogue than anything else, and this item is the leading feature, while the subject of electric light wires insulated with India-rubber *not* vulcanised is referred to at less length. A few sundry articles are mentioned and priced, *i.e.*, twin flexible electric light cords, jointing materials and wood casings. As a kind of preface to the list are some simple instructions for jointing.

Messrs. King, Mendham & Co., of Bristol, have published a show list of their manufactures, which they head "Everything electrical." The sheet is intended to be hung up in a laboratory for reference, although it is not so suitable for the purpose as might be desired, seeing that it is on not very thick paper and printed on both sides. Notwithstanding this the list is a useful one, containing a large amount of information and a still larger number of illustrations. Switches, bells, Wimshurst machines, batteries, telephones, and a variety of small apparatus for students, are illustrated.

We have received a copy of the latest catalogue issued by the Maschinenfabrik Oerliken. It is printed in German, and deals purely with electric railways and electric trams. There are several interesting photographs, and a number of other illustrations, contained in this small pamphlet.

Pontypool Electric Light and Power Company.—In connection with this company about 90 gentlemen, representing public and commercial interests, were entertained at luncheon at the Crown Hotel, Pontypool, on Wednesday last week, through the kindness of Mr. W. Pegler, jun. Mr. J. C. Howell, of Llanelly, occupied the chair.

Primary Battery Installation.—Dr. W. E. Raw, of Penge, has selected the Weymersch Electric Battery Syndicate's system for the electric lighting of his house. The installation is at present small, but it is intended to extend the light over the whole house, shortly. The installation consists of 3 Weymersch primary batteries arranged to charge an accumulator consisting of 16 11-L. E.P.S. cells in two halves, which are connected to the battery by a double-pole two-way switch. The accumulator is connected up in series to the terminals of the lamp circuit in the house. This arrangement admits of great economy in a small installation, as a considerable amount of copper is saved in the mains, and a great saving is effected in the primary battery plant by charging the accumulator half at a time. Moreover, by means of the double-pole two-way switch, the lamp circuit can always remain connected to the accumulator irrespective of whether the Weymersch battery is charging or not. Again, as only half the accumulators are being charged at a time, a regulating switch on the discharge circuit from the accumulators is not so necessary as if the whole 16 cells were being charged simultaneously. The working of the installation has completely fulfilled every promise made by the syndicate, and has given entire satisfaction.

International Electrical Syndicate, Limited.—In the Chancery Division of the High Court of Justice, on Wednesday last, Mr. Justice Vaughan Williams heard a petition of G. H. Hodgson for the winding up of the International Electrical Syndicate, Limited. Mr. Fillan said he understood that this petition for the winding up of the company was unopposed. The nominal capital of the company was £12,000, and the amount paid up was £10,000. The application was by a shareholder who had a holding of £500 paid up. The object of the formation of the company was to buy some patents for electrical motors, and to work them in England. The company was incorporated in April, 1891, and since then nothing had been done—no business whatever had been carried on. He therefore applied for a winding up order. After a certain amount of discussion the order for winding up the company was made.

Private Lighting at Polmont.—The residence of Mr. H. A. Salvesen Blairbank, Polmont, is being fitted with the electric light, as is also the residence of Mr. Ray. The current for these is to be supplied from Blairlodge installation, which is being largely added to at present on account of the new church and sanatorium in connection with the school presently in course of erection. In the church will be a large pipe organ, which is also intended to be blown by an electro-motor. The sanatorium, which is some distance from the main buildings of Blairlodge, is to be connected by telephone. These installations are being carried out by Messrs. T. Laurie & Co., electrical engineers, Falkirk.

Liverpool Overhead Railway.—The first train on the Overhead Railway was run on Tuesday, carrying the directors and their friends. The trip was very satisfactory, the behaviour of the main engines and dynamos being all that was anticipated, and the experiments indicated a very successful issue. There were present the chairman of the railway company, Sir William Forward, and the whole of the directors; Mr. J. H. Greathead and Mr. Francis Fox, the engineers; the contractors, the Electric Construction Corporation, Limited, were represented by Mr. Thomas Parker, who received the congratulations of the whole of the party.

New Business.—We are informed that Messrs. Russell and Co. intend carrying on the business of electrical engineers and contractors at 11, Queen Victoria Street, E.C., under the management of Lord Russell, lately of the firm of Messrs. Swinburne and Co. They intend listing and supplying every requisite for electrical work of any description, in addition to contracting for the supply, erection, or equipment of plant. With this view Messrs. Russell are about to issue a catalogue of apparatus for every kind of electrical work, including lighting, power transmission, telegraphs, telephones, mining, bells, &c.

Electric Lighting of Smithfield Markets.—The late Lord Mayor and the Lady Mayoress attended at Smithfield Markets last Friday to inaugurate formally the lighting of the markets by electricity, which has been carried out on behalf of the Corporation of London by Messrs. Julius Sax & Co. The number of incandescent lamps to be fitted on the premises of tenants in the markets reached 12,000 of from 15 to 50-candle-power each, and the main avenues would be lighted with 100 lamps of 50-candle-power each. The Lady Mayoress switched on the light, amid the cheers of those assembled.

The Electric Light in the City.—Progress continues still to be made in the City district, both as regards private and public lighting. Since our last report we note that work is being carried out in the premises of Mr. John Taylor, fruiterer, 63, Old Broad Street.—Fitting work is also being done in the premises of Stewart's Luncheon Bar, Ludgate Circus.

"Unique" Switches.—Owing to the increasing demand for the "Unique" switches, we note Mr. A. P. Lundberg has found it expedient to add greatly to his bench room, to enable him to cope with greater success his numerous orders. Though but a short time in the market, these switches are rapidly coming into favour, and already over 15,000 have been sold.

Exhibition at Sheffield.—At the exhibition held in the Sheffield Drill Hall, Messrs. the Sheffield Electric Engineering Company, of 50, Napier Street, exhibited three electro-plating dynamos.

Personal.—Mr. Arthur W. Hine informs us that he has resigned his position as a director of the Roper's Electrical Engineering Company, Limited.

Electric Lighting in Dublin.—There are a number of large installations being carried out in Dublin, supply being taken from the Corporation's public mains. Amongst the important ones we notice the offices of the Sun Insurance Company in Trinity Street, who are having a handsome wrought iron crescent bracket placed over the entrance, in the centre of which will be arranged a large sun brilliantly lighted with 6 lights, also a novel form of automatic time cut-out, so that the light may be left burning to any hour at night, these novel arrangements have been suggested by the company's engineer. The work is being carried out by Messrs. Curtis Brothers, electrical engineers, 10, Suffolk Street, Dublin. This firm have also several other important installations in hand.

The Electrical Supplies and Fittings Company, Limited.—The following is a list of the premises at present being fitted up for electric lighting by the Electrical Supplies and Fittings Company:—Lady Selina Hervey, 2, Connaught Place, W.; H. Davison, Esq., 3, Penywern Road, S.W.; C. E. Melchers, Esq., 2, Moreton Gardens, S.W.; The Autotype Company, New Oxford Street, W.C.; St. Jude's Church (extension of lighting in school room) West Kensington; A. L. Brooke, Esq., Bramham Gardens, S.W.

Dissolution of Partnership.—In last week's issue we referred to the dissolution of partnership in the firm of Messrs. Rashleigh Phipps & Dawson. Mr. Phipps is now doing business as Rashleigh Phipps & Co., while Mr. Dawson trades at 53, Berners Street, W., under the style of Roger Dawson.

CITY NOTES.

Western and Brazilian Telegraph Company, Limited.

THE twenty-fourth ordinary general meeting of this company was held yesterday at Winchester House, Old Broad Street, Mr. W. S. Andrews presiding.

In the absence of Mr. R. M. Cunningham (the secretary), on account of illness, Major WOOD, the managing director of the company, read the notice convening the meeting, also the minutes of the last meeting.

The CHAIRMAN, in the course of his remarks, first dealt with the receipts. They had had reason to anticipate what they had now reason to realise, that owing to the adverse state of exchange in Brazil, the outcome of the half-year that they were dealing with on this occasion would not be found to be so satisfactory as it had been on previous occasions. In their case, however, it was not so bad as it had proved to be in many other companies, the reports of whose meetings showed that owing to the same cause there was no dividend at all. It was far from gratifying to the board to go before them with a reduced dividend. They had done their best to combat with the difficulties that they had had to face, and, on the whole, although they regretted to see that diminution of gross revenue, they felt that, after all, it was owing to a cause that they had no power to control. They had not only had to deal with further reductions in the exchange in Brazil, but there was also a reduction of tariff between this country and Brazil which had a certain effect upon the revenue of the last half-year. The gross revenue for the half-year was £84,021 16s. 9d. compared with £104,962 9s. 7d., showing a falling off of £20,940 12s., but, of course, in that falling off there was no less than £15,539 owing to the item of exchange. The expenses account amounted to £39,140 16s. 8d., against £38,638 10s., showing an increase of £502 6s. 8d. He then proceeded to analyse the figures. The total cost at stations was £17,253, against £18,675, showing a decrease of £1,421. There were, in fact, decreases under 10 heads, amounting in all to £2,124, and increases under three heads, making £703, and out of that increase of £703, no less than £574 15s. was owing to medical expenses, which was an unavoidable item, on account of the extremely sickly season. They would therefore see that there was a very considerable saving of expenditure under Abstract A. Under Abstract B it was pleasing, in one way, although unsatisfactory in another, that the ships ought to have shown, and would have shown, a decrease of £2,833 17s. 9d., of which £500 would have been owing to the *Norseman* having assisted in putting the loops, and that proportion of her expenses being charged to the loops; but there would still have been a reduction of £2,300, but, unfortunately, the *Norseman* was caught in a very heavy gale. She sprang a leak, the sea was extremely high, and the vessel almost given up for lost; in fact, she was really abandoned; the men actually left her and went on board a ship close by, but when the weather calmed down they went back to her. She was towed into Montevideo and grounded. After that, when circumstances allowed, she went into dock, and was repaired; but just at that particular period, when that unfortunate ship was under repair, two of the company's cables broke. There was only one thing for them to do. Fortunately the *Scotia*, of the Construction Company, was on the spot, and they hired her, and the cables were repaired, but, of course, they had to pay the cost of that; but by doing so they had the cables put into order, and thus prevented loss of revenue. That was again a circumstance absolutely beyond their control. These expenses had therefore shown an increase of £1,487, instead of a decrease of £2,833. Under Abstract C, there was a small increase of £300 under seven heads, and a small reduction under two. The outcome of all that was that the receipts were £84,021 16s. 9d., and the expenses £39,140 16s. 8d., leaving a balance of £44,881 0s. 1d; then they brought forward from the preceding half-year £4,486 18s. 2d., making, together, £49,367 18s. 3d. From that there was to

be deducted the interest on debentures and the debenture redemption fund, reserve fund, and proposed dividend, leaving to carry forward £16,062. After referring to the "commercial stagnation" in Brazil, he said that the only consolation they seemed to have was that an improvement of affairs was beginning. It was, therefore, not altogether so discouraging as the mere figures themselves seemed to indicate, because they might hope that there was a better time coming. After referring somewhat lengthily to the competition they had had to deal with, the new ship being built, and the £50,000 debentures which the company had power to issue, but which they had up to the present done without issuing, he moved the adoption of the report and accounts, and the declaration of a 2 per cent. dividend, payable on the 11th inst.

MR. JOHN COPPEN (who was at the last meeting elected a director at the wish of the shareholders), made a few remarks in seconding the resolution.

A few questions having been asked and answered, a vote of thanks to the chairman, directors, and staff closed the proceedings.

Elmore's Patent Copper-Depositing Company.

THE following circular has been issued by the secretary to the shareholders in the Elmore Patent Copper-Depositing Company, Limited:—

"I am instructed to inform you that the accounts of the company for the past year are now in course of preparation, and will be shortly submitted to you. My directors have pleasure in stating that since the date of the last general meeting the process has undergone further important developments, which have been brought to a thorough state of perfection. Not only are the tubes most satisfactory, but at the next meeting of shareholders specimens of pans and similar objects made by the process will be shown of a form that had hardly been thought possible to make, together with air-pressure cases and such-like complicated chambers with closed ends, all of which are difficult and expensive to manufacture by existing processes. A thorough reorganisation has taken place with regard to the management of the business, and it has been considered necessary for the effectual control of the company's affairs that the offices and books should be removed to Leeds, and that the board meetings should be held at the works. To facilitate this change, three of the London directors have retired in favour of two gentlemen resident in the Midlands, who have agreed to join the board, both of this company and of Elmore's Wire Manufacturing Company, Limited. The two new directors—Mr. Terah Hooley and Mr. William Goode Johnson— are well-known men of great experience in the management of works, who have both been most successful in their own manufacturing businesses. These gentlemen are throwing themselves with energy into the development of the Elmore business, and after having thoroughly satisfied themselves, from personal investigations as well as from the opinion of those in the trade, have lately acquired a very considerable interest in the companies, one of them holding over 10,000 shares. They have further announced their intention of giving a large portion of their time to the development of the business and seeing personally to the details of the same at the works, as well as of obtaining the capital necessary for the future development. The success of the commercial and financial future of both companies may therefore be said to be secured, their technical success having been proved some time since. Notice will be given in due course to the shareholders of the removal of the registered offices."

Aluminium Company.

THE fifth annual ordinary general meeting of this company was held on Monday last, at Cannon Street Hotel. Mr. Gerald W. Balfour, M.P., presiding.

The Secretary (Mr. G. H. CLARKSON) having read the notice convening the meeting,

The CHAIRMAN, in moving the adoption of the report and accounts, related the history of the company, with its misfortunes and disappointments. He stated that the electrical methods of producing aluminium were still always ahead of them, and they had found that they could no longer hold the field against them. The knowledge they had acquired of the properties of the metal and its alloys would enable them to do a certain amount of business in connection with it, but they had long ago bid farewell to any expectation of making the large profits which they at first anticipated. In spite of the series of disastrous blows which had come upon them, they nevertheless determined to persevere and, if possible, to save the sinking ship. Those who had any acquaintance with the difficulties of selling a manufacturing establishment which had been erected for the purpose of carrying on a process which no longer paid, would be aware how hard it was to recover under those circumstances anything like the sum which had been spent. They were resolved to leave no stone unturned to save the shareholders at least some portion of the capital that they had expended. They had given up all hope of that particular branch of business in which they started, they nevertheless thought they saw the opening for a new branch of industry. He was glad to say their perseverance had been rewarded; they had succeeded in creating that new branch, but not without encountering many difficulties and discouragements and disheartening delays. It was true that the trading account still registered an adverse balance, though a comparatively small one, but during the half year from January to June the works at Oldbury showed a profit of between £2,000 and £3,000. After some further remarks regarding that profit, he referred to Mr. Castner's new electro-chemical process, which was mentioned in the report, and after dwelling somewhat lengthily on the subject, he appealed to the shareholders not to press the directors too much upon that point as to what it really was. The directors thought it was not in the interests of the shareholders that the nature of the process should be revealed until they were in a position to exhibit it actually at work upon a commercial scale.

Sir HENRY E. ROSCOE, M.P., F.R.S., seconding the adoption of the report, said that amongst the orders for their sodium, they had one of sufficient magnitude to pay the whole of the interest on the debentures, already in hand.

After one or two questions regarding Mr. Castner's process had been put to the chairman and answered, the report was unanimously adopted.

The retiring directors, and also the auditors, were re-elected, and a very hearty vote of thanks to the chairman and directors terminated the proceedings.

The West India and Panama Telegraph Company, Limited.

THE directors' report for the half-year ended June 30th, 1892, to be submitted to the thirty-first ordinary general meeting, November 15th, 1892, reads as follows:—

"The directors submit the accounts for the six months ended June 30th, 1892. The amount to credit of revenue is £44,148 17s. 7d., against £47,641 16s. for the corresponding half-year of 1891, and the expenses have been £28,589 6s. 4d., against £24,868 16s. for the same period in 1891, leaving a balance of £15,559 11s. 3d., which, with £2,122 16s. 5d. brought from last account, makes a total of £17,682 7s. 8d., with which it is proposed to deal as follows:—

	£	s.	d.
FIRST PREFERENCE SHARES—			
Dividend, 6 months to June 30th, 6s. per share	10,368	18	0
SECOND PREFERENCE SHARES—			
Dividend, 6 months to June 30th, 6s. per share	1,400	14	0
ORDINARY SHARES—			
6d. per share (free of income tax)... ...	2,208	0	6
Balance to current half-year's account ...	3,704	15	2
	£17,682	7	8

The traffic receipts for the six months show a decrease of £3,762 3s. 11d., as compared with the corresponding period. This decrease is due to the reduction of tariff made in June last year. The cost of repairs to cables amounted this half-year to £22,879 0s. 10d., as compared with £11,936 14s. 2d. for the corresponding period. Of this sum £8,528 has been charged against reserve. The increased expenditure is due to the number of interruptions, and to the laying in of greater lengths of new cable to renew and strengthen the system. The most difficult repairing operation, included in the above expenditure, was that of the Jamaica-San Juan section, where the fracture was in a depth of 2,234 fathoms. Owing to this great depth of water, the old cable broke frequently in the attempts made to lift it to the surface, and this necessitated an expenditure of 85 knots of new cable to bridge over the gap. The company's ss. *Grappler* has been ordered to London to be surveyed, in accordance with Lloyd's requirements, and to be fitted with a new boiler. She will return to the West Indies with a cargo of 256 nautical miles of cable for stock. It will be in the recollection of shareholders that it was announced at the general meeting held in May, that the board had to regret the loss of their valued colleague, Mr. Ford, whose death had occurred since the issue of the report then submitted. Sympathy with his family, and appreciation of the value of his services to the company, were expressed at the meeting. The board, from motives of economy, do not propose to fill up the vacancy.

Collier Audible Telephone Company.—A resolution was passed on October 1st, and confirmed October 17th, as follows:—That the syndicate be wound up; that G. D. Ingall be liquidator; and that the liquidator carry out the sale of the assets on the terms of the contracts made between this syndicate, Ernest Hampson, and the Collier-Marr Telephone and Electrical Manufacturing Company, Limited.

Stock Exchange Notices.—The Stock Exchange Committee have ordered the undermentioned securities to be quoted in the Official List:—City of London Electric Lighting Company, Limited—Further issue of 9,848 ordinary shares, Nos. 70,153 to 80,000.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 6th, 1892, amounted to £891; corresponding month, 1891, £783; increase £108; total receipts to date, 1892, £15,163; corresponding period, 1891, £13,756; increase £1,407.

The Great Northern Telegraph Company. The traffic receipts in October, 1892, amounted to £24,000. 1st January—31st October, 1892, £223,600 corresponding months, 1891, £237,800; corresponding months, 1890 £232,800.

The Western and Brasilian Telegraph Company, Limited. The receipts week ending November 4th, after deducting 17 per cent. of the receipts payable to the London Platino-Brasilian Telegraph Co Limited, amounted to £2,834.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, November 3rd.	Closing Quotation November 10th.	Business done during week ending November 10th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100—103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	50½— 51½	50½— 51½	50½	50¼
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	91 — 92	91 — 92	92	90⅜
2,876,140*l*	Do. do. Deferred	Stock	11¼— 11⅝	11¼— 12	11⅝	11¼
130,000	Brazilian Submarine Telegraph, Limited	10	10⅜— 11¼	10⅜— 11¼	11⅛	10⅞
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	104 —108	106	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3¼	3 — 3¼	3¼	3 1/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2¼— 2½	2⅜	2⅛
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	10½— 11	10⅝— 11¼	10⅞	10 11/16
$7,716,000	Commercial Cable, Capital Stock	$100	168 —173	174 —176	175	174
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	1/— 3/8	1/— 3/8	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos 1 to 20,000	5	5¼— 5⅜	5¼— 5⅜	5 9/16	5½
16,000	Cuba Telegraph, Limited	10	11½— 12½	11½— 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼— 3⅜	3 — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11⅝	11½— 11⅝	11⅝	11½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
70,000	Do. 6 p. c. Preference	10	15½— 16	15¾— 16¼	16⅛	16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	110	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112 xd	109 —112 xd	111½	110
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅛— 15⅜	14⅞— 15⅛	15 5/16	14⅞
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	104 —107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	104 —107	106½	104½
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112	109 —112	110½	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	105½	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	105⅜	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4½— 4⅝	3½— 4	4¼	3
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/8— 5/8	3/8— 5/8	1 2/16	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	1½— 1¾	1⅝— 1⅞	1½	1⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	3/4— 1	5/8— 7/8	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1½— 2½	2 — 3	2⅞	2 1/16
180,227	Globe Telegraph and Trust, Limited	10	10⅛— 10⅜	10 — 10½	10⅜	10⅛
180,042	Do. do. 6 p. c. Preference	10	15⅛— 15⅜	15⅛— 15⅜	15⅜	15
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19	18⅞— 19¼	19	18⅞
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	5½— 6½	5½— 6½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½— 22½	21½— 22½	22¼	21⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 45 xd	43 — 45 xd	44⅜	44
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	...	..
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½— 7	6½— 7	6⅞	6⅜
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	104 —107	104 —107	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅞	4⅜— 5	4 15/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 14½	14 — 14½	14½	14
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½— 14	13½— 14	13⅜	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	111 —113	111 —113	112½	111½
48,000*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	3½— 4	3⅝— 3⅞	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
10,802	Reuter's Limited	8	7 — 8	7 — 8	7 11/16	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 — 8½	8 — 8½	8⅜	8 3/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞— 8¼	8 — 8¼	8⅜	8¼
3,381	Submarine Cables Trust	Cert.	117 —121	117 —121	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½— 4	3¼— 3⅜	3 11/16	3½
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	45 — 47	45⅝	45⅜
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —105	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2¼— 2⅜	2⅛— 3	2½	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½— 7½	6½— 7½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	102¼	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	8½— 9	8¼— 8⅜	8⅝	8½
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6½	6 3/16
33,129	Do. do. do. 5 p. c. Deferred	7½	2¼— 2⅜	2¼— 2⅜	2¼	2⅜
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅜— 1⅝	1½— 1⅝	1 7/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10¼— 10⅜	10 1/16	10⅜
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½	9 — 10	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	103 —106	103 —106	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125 xd	120 —125 xd	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½— 6	5½— 6	5⅜	5½

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—3 per cent. (October 20th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7¼—7⅞.—Electric and General Investment, shares of £5 (£1 paid), 2½—3½.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6¾—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—5⅜.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 108—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2½—3.

LEGAL.

THE THREE-WIRE SYSTEM.

DR. JOHN HOPKINSON *v.* THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

(*Continued from page* 547.)

THIRD DAY.—NOVEMBER 4TH.

Dr. HOPKINSON, further re-examined by Sir RICHARD WEBSTER, was asked: Merely as an electrician and speaking of this specification as directed to a workman, would it lead any workman to establish the arc light without further directions?—No; the whole specification is addressed to incandescent lighting in parallel, although arc lighting in parallel might fall in as an incidence. It is difficult to use arc lamps on a parallel circuit; it is done, I cannot say whether it could be done at that time, but it can be done to-day.

If used for arc lighting must there, in your opinion, be invention in order to distribute the current among the different consumers?—Yes; having the supply available you might find it convenient to use it in that way.

At that time were the regulators of arc lights sufficiently good to enable people to run many arc lights in parallel?—I do not know that any were run in parallel at that date; certainly none were run in a really satisfactory way. Until very recently a very considerable resistance had to be added to each arc light to keep it steady, but the regulators of late have improved so much that that resistance may be reduced to a very small amount to-day.

Would anybody not wanting incandescent lighting use the three-wire system?—Certainly not; you could not get the advantages mentioned in my specification if you required arc lighting. You would have to put down a special plant for running those arc lights in series.

Looking at figures 1 and 5 in your specification, would anybody consider that that was an arc lighting system or an incandescent system?—It would be absolutely clear to anybody that every one of those was intended to indicate an incandescent light.

One of the merits of your system is a great saving of copper?—Yes.

Would the use of that middle wire in the Alexandra Palace diagram save any copper at all?—No; unless you take it as putting in two circuits instead of one.

Would any competent electrician in 1882 be led to reduce the size of the middle wire?—Certainly not.

Is there any analogy between that and your system except that the middle wire is at times a conductor?—I think not.

The same would apply to the Inchicore installation?—Yes.

Would people think of applying the three-wire system to arc lighting?—No; because it would be more costly in power and copper than the methods employed by the Brush and other companies before the date of this patent.

May I take it that in your opinion an electrician reading your specification would have his mind directed to the multiple parallel system?—Certainly.

WITNESS then said that it was only when connected in series and not in parallel that Mr. Wylde's knowledge as to rigid connection of the armatures applied, and that he did not think when he made his discovery that he had ever seen Wylde's paper—if he had he had clean forgotten it, being at the time of its publication engaged on very different matters.

Lord KELVIN, examined by Mr. ASTON, Q.C., said that he had specially directed his attention to the practical application of electricity for electric lighting.

I believe you were one of the earliest to apply electricity for the purpose of lighting your own study and house?—I believe my own house in the University of Glasgow is the very first house on this planet which was solely lighted by the electric light. That was about the end of 1881.

What does the plaintiff's specification convey to your mind as an electrician?—Distributing at that time meant a great improvement, which became realised by Swan and Edison about 1879 or 1880. An inquiry before a Royal Commission in 1879 showed there was a great want of a means of what was then called "the distribution of electricity." The arc light was the only kind of electric light known at the time of the commission, and many questions were put to the witnesses as to discoveries that would lead to the distribution of electricity. It was rumoured that Mr. Edison had such a discovery, but nothing definite was put before the commission.

Taking the first part of the plaintiff's specification which relates to the three-wire system, in your opinion is that a clear and intelligible description?—Perfectly clear and perfectly intelligible; it describes the three-wire system with perfect clearness, and without ambiguity of any kind.

It is suggested that a further direction as to Foucault currents would be an advantage. What are Foucault currents?—It is a name given to currents discovered by Faraday, but beautifully illustrated by experiments by Foucault, a French experimenter of great genius. They are caused by variation of the electric currents, or by variation of magnets in the neighbourhood of a conductor capable of conveying electric currents.

Would you say the directions are sufficient to enable the invention to be carried into effect when alternating currents are employed?—Quite sufficient.

In your opinion was the three-wire system as described in Dr. Hopkinson's specification new in July 1882?—Certainly, as far as my experience went and my knowledge allowed me to judge.

Was it useful?—Very useful indeed; it really made the difference between electric lighting being possible on the low pressure alternating current system, and almost impossible on account of the expenditure in copper for central station lighting in towns.

Then there would be a saving of copper?—Yes.

What do you say with reference to the working of the three-wire system?—It allows lights to be freely turned on and off without producing any serious practical difference either upon lamps on the same side or the other side of the central conductor.

Having regard to the quantity of wire employed, do you know of any system which, prior to 1882, would have enabled that to be done?—No.

You yourself then used only two wires?—Two wires; one wire on which the current would go and the other come back.

Does the Alexandra Palace diagram anticipate the three-wire system of Dr. Hopkinson?—No.

Do you know of any system referred to in the particulars of objection, or any system which has been brought to the attention of my lord in court, which does anticipate the three-wire system of the patentee in this case?—No.

Now turn to the first head of the invention—the regulating device (specification page 3, lines 12 to 30). Are those descriptions sufficient to enable what I will call shortly the differential regulator to be employed in the manner directed?—Quite sufficient.

Would that regulator have great utility in your opinion?—Great utility.

What do you say to the objections in this case founded on Abdank's specification?—Mr. Abdank's specification does not disclose anything which could help towards the achievement of the object of the first part of Dr. Hopkinson's invention. It was not Abdank's suggestion alone that could possibly have given the idea of two wires, thick and thin; that was a matter of common knowledge to Abdank and all others at that time.

Can you take the knowledge described in Abdank's specification and use it for Dr. Hopkinson's invention?—Certainly not; it would have to be altered. Besides, Abdank's object is different, and the thing is different.

With all the knowledge you now possess, what do you say with regard to the novelty of the differential regulator described in this specification in July, 1882?—I think it was quite novel, and very important.

Cross-examined by Mr. FINLAY: The multiple bridge system of course is not part of this invention?—No.

If I rightly understand you, what you regard as the merit of this patent is the application of a third wire to a system of multiple bridge lighting?—The application of a third wire to a point intermediate between positive and negative extremes of two dynamos in series.

Witness was handed the Inchicore and Alexandra Palace diagrams, and asked: Is not what you regard as the merit of this invention the application of a third wire connected in the same way as in those two diagrams to a system of multiple arc lighting?—It could not have been of any practical use to a system of multiple arc lights, because multiple arc lights would naturally be put in series.

Is not that the three-wire system as it is patented?—That is the three-wire system applied to two arc lamps.

As applied to two arc lamps hasn't the three-wire system as applied to two arc lamps, certain advantages?—As arc lamps were regulated at that time, I do not see the advantage, because, if a lamp went out, it was immediately short-circuited.

If you had two arc lamps in series not being provided with shunt regulators, would not the application of the third wire enable these two arc lamps to be burned in series when they could not be burnt in series without it?—Yes, I think it would.

Would the use of the third wire have any advantages in the way of economy, either of copper or of energy in application to such a system as you see there—the two arc lamps in series?—It would depend on the distance of the place of supply.

Do you mean a saving might be effected if the distance were considerable?—Yes.

Would there be an appreciable saving of copper in that case?—Yes.

And of energy?—None at all, relatively to the way arc lamps were worked at that time.

Would you economise your fuel by this arrangement?—The fuel required for two lamps would not be sensibly altered at all.

Was it not possible to re-arrange arc lamps in parallel?—I do not say it was impossible, but I know there were tremendous difficulties against it.

Would not Serang's lamps work excellently in parallel?—I had one in my laboratory a very long time ago; I do not think it would work in parallel; I know it was quite unsuited for practical electric lighting.

Do you know Gülcher?—Nobody in his senses would dream of using such a complex lamp in connection with arc lamps then, or now, unless a number of arc lamps had to be placed on a circuit already provided for the supply of incandescent lamps.

I must ask you to point to the words in the specification which you suggest had the effect of confining this to a system of multiple bridge incandescent lighting?—I do not know that it is absolutely confined, but it is clear the object of the patent was for incandescent electric lighting. The substantive "distribution" technically meant subdividing into smaller lamps. Besides that I see actual pictures of the Swan or Edison lamps in the drawings wherever lamps are referred to.

It is not confined to incandescent lamps?—No; one pair of arc lamps might be put on that bridge instead of a single incandescent lamp.

Then if there were any advantage in applying the three-wire system to arc lamps in series, applying the three-wire system to them would fall under this patent.

Mr. ASTON, Q.C.: Is not that construction.

Mr. JUSTICE ROMER: I think so.

WITNESS then stated that the specification seemed to him to imply that the subject of the invention was incandescent lighting, but that the inventor was not precluded in either part from using arc lamps where they could be conveniently placed on circuits designed for incandescent lamps.

WITNESS was then asked as to the Foucalt currents. He said that a workman would not find it more difficult to adjust for alternating currents than for direct currents. With regard to the Gülcher lamps, he thought it probable that Gülcher's being a low pressure machine the lamps were put to run in parallel.

In re-examination by Mr. MOULTON, Q.C., WITNESS said the contrast between lamps in series and parallel bridges was very well known at the date of the patent.

The introduction of the parallel bridges was the thing which made incandescent lighting possible?—Certainly.

Mr. REGINALD BELLFIELD, examined by Mr. ASTON, Q.C., said that he was a member of the Electrical Institute and an associate member of the Institute of Civil Engineers. For many years he had given attention to the application of electricity for lighting purposes. He knew the state of things about the years 1881 and 1882. He agreed with the evidence of Dr. Hopkinson and Lord Kelvin with regard to the state of knowledge at that period. Lamps were then arranged in multiple bridge on a two-wire system. In 1882 he did not know of any such application of the three-wire system for the purpose of electric lighting as was described in the specification under the second head. He agreed as to the sufficiency and utility. He was the practical electrician of the Westinghouse Company. Any application of the three-wire system to arc lamps in series was not within his knowledge; such an application would be very detrimental. The Inchicore system was totally different from the plaintiff's. The only thing it had in common with the three-wire system, was that it had two sources of electricity arranged in series. It had three wires, but he could not see that the three wires performed the same function at all. He had experimented with the instrument with an alternating current, with the result that it was largely used in America; but not with dynamos in series. He was present at the Crystal Palace Exhibition of 1882, but saw no application of the three-wire system.

Cross-examined by Sir HORACE DAVEY: He commenced his practical experience with these matters about the time the plaintiff's patent was taken out. He did not draw a distinction for the purpose of this patent between the use of two dynamos and a dynamo in which two coils in series were wound upon the same armature.

In what respect does that Inchicore dynamo differ from the pair of dynamos referred to in the specification?—In the pair of dynamos referred to in the specification each dynamo can be separately regulated, and you can preserve a constant potential at the lamps.

Where does the patentee say it is an essential feature of his system that you should have a difference of potential at each dynamo?—The whole thing as worded points out that.

WITNESS then said that the regulator used at Sardinia Street was a modified form of the plaintiff's, the chief engineer of the Westinghouse Company in America (Mr. Shallenberger) having made alterations. In every place it had been put up with these additions; it worked well.

Have you ever known it worked without these additions?—I am not sure; I might have made it without these additions in the experimental apparatus. For practical work I have never worked it or seen it worked, except in this model, where it works perfectly.

In answer to his LORDSHIP, WITNESS said that the modifications were only for special circumstances.

In further cross-examination he said that other people had paid royalty; the defendants were about the first the company had heard of who had worked without paying royalty.

Sir FREDERICK JOSEPH BRAMWELL, examined briefly by Mr. HOPKINSON, Q.C., said that the plaintiff's specification solved the problem of saving copper; to his mind the Alexandra Palace and Inchicore systems did not solve that problem.

Is the word, "distribution" applicable to such a system as you have on the diagram before you—the Inchicore or Alexandra Palace?—I do not think so. "Distribution" means the dividing of the current; this means no division of the current.

WITNESS said that in his opinion the plaintiff's regulator was a useful instrument. Having regard to all he knew and had seen, it was something which required invention. He had always said he did not know where invention began or ended; but the plaintiff's instrument was by no means an obvious application of anything which he knew at the time or had ever heard of since the date of the patent. He thought the regulator could, without difficulty, be adapted to alternating machines, following the plan pointed out in the specification.

Cross-examined by Sir HORACE DAVEY, Q.C.; Taking all your great acquirements, you are not an electrical engineer?—I thought I was. (Laughter.)

You are a director of the South Kensington Electric Company?—Yes.

Is it within your knowledge that in South Kensington arc lights in large numbers are arranged in parallel on the system?—Yes, it is within my knowledge that the arc lights are arranged on the three-wire system, which also supplies the incandescent lights.

I am told there are as many as 40 arranged in parallel in one shop in the High Street?—I cannot tell you; I know there are a considerable number.

Arranging them in that way would obviate the danger of inducing a high voltage current into a dwelling house?—Yes.

The arrangement of lamps in series or parallel was well known before the date of Dr. Hopkinson's patent?—Yes.

What is to prevent my altering my series arrangement to a parallel arrangement?—You would have to alter your dynamo so as to deliver as much more current as was equal to the number of your lamps, and as much less potential as was the original potential divided by the number of lamps.

WITNESS then said that if an electrical engineer had his arc lamps in parallel to begin with, he could without difficulty and with the proper apportioning, substitute incandescent lamps; if he had his arcs in series to begin with he would find some difficulty in substituting incandescent lamps.

In re-examination by Mr. MOULTON, Q.C.: WITNESS said that assuming the three wires were on one axis, it certainly would not have led him to devise the system by which he could make the middle wire very much smaller. With respect to there being 40 arc lamps in one place, he might say the number of incandescent lamps lit by the South Kensington Company was between 40,000 and 50,000; so that the arc lamps referred to were a very small fraction of the whole system.

This closed the case for the plaintiff.

Mr. JUSTICE ROMER said he should like to hear counsel for the plaintiff address him specially on the construction of the specification.

Sir RICHARD WEBSTER said he understood the suggestion that was made with regard to this specification was that it might be construed as including a claim to, or as directing a person to make, a system of arc lighting. There was no reason for anticipating any such point, the objections containing nothing pointing to it beyond the general observations that the plaintiff's invention was not subject matter of a patent, or that it was merely an application of common knowledge.

Mr. JUSTICE ROMER: The point you have to argue is whether upon its true construction the specification would include a case where there were nothing but arcs in series; then you have also to consider whether it would include arcs in parallel.

Sir RICHARD WEBSTER said that if it meant that one of the bridges consisting of incandescent lamps, or one of the houses consisting of half a dozen incandescent lamps, could be taken out and an arc light put in its place as an incidence in the system, but no part of the special novelty of the system, he was not there to dispute it. He contended the only point of attack which could be successfully made against this patent was, if it covered a claim to series lights, whether consisting of arcs in series or any other method of using lights in system, which was not multiple parallel bridge. If fairly read, he protested against it being suggested that this specification would, to any electrician, include lamps in series distinguished from lamps working in parallel. The specification must be construed as it spoke to people in 1882. The evidence with regard to the state of facts was that series lighting was perfectly well known, that for years it had been the practice to include lamps in the same series and light them by a current, of which the potential at each lamp diminished as it went down the chain. It must also be noticed that for some two-and-a-half years before 1882 incandescent lighting by distribution had become a commercial and known fact, and that was by the distribution or breaking up into parts which crossed from one conductor to the other in parallel the volume of the electric light. It was not suggested that anybody would speak in the year 1882 of a series of arc lights as a "lighting by distribution." He did not say it might not be a popular expression, but it was not one which would be used by anybody who knew what he was talking about. In order to see what was the ambit of the patent, the provisional specification must be looked at. The provisional specification said: "My improvements principally relate to maintaining the electromotive force on a system of conductors for an electric supply at a fixed potential." You did not desire to have, and you could not have, the "maintaining of a fixed potential" on a system of conductors if you had series lamps.

Sir HORACE DAVEY interposed, saying that the patentee could not use the provisional specification for the purpose of interpreting his patent.

Sir RICHARD WEBSTER said it had been decided in the House of Lords that you must look at the provisional specification to see what was the plaintiff's invention. He never sought to use it. He had never sought to use it for the purpose of interpreting. He would go to the complete specification, as the words were identical.

Mr. JUSTICE ROMER: I want to hear you upon how it is that the words, "at a fixed potential" show that the draughtsman must be pointing simply to the multiple arc light in parallel.

Sir RICHARD WEBSTER said for this reason, that if you had your conductors simply running through a series, the potential varied at every lamp. No electrician could honestly and fairly go into the witness-box and say that he would read, "conductors at which a fixed potential was to be maintained as indicating series arc lighting." In the case of series arc lighting you had no fixed potential, and in the case of multiple parallel bridge you had fixed potential. It was made clearer later on. "When electricity is delivered by means of a pair of conductors to a distance from the station where the electricity is generated, there is a fall of potential due to the resistance of such conductors, greater as the current is greater, and if it be desired to maintain the potential constant at the delivery end, it is necessary to increase the potential at the supply end, as the current increases, in a suitable manner." Those words did not apply to it in arc lighting. As the current increased means were found to put upon the system more parallel bridges, which drew more out of the system, and called for an increase of the potential. The defendants were availing themselves of the fact that owing to the improvement in arc lighting you could put an arc light on a parallel bridge. "The application of this instrument to an extended system of electrical supply with a network of distributing mains is important. For each machine I provide a pair of feeders of a size appropriate to the current they are to carry, but independent of the distance they have to go. Each pair of feeders goes to and is connected to some part or other of the system of distributing mains, and by the use of my invention I am able to keep the difference of potential constant at or near the point where the feeders join the distributing mains. By using a sufficient number of feeders I am able to keep the potential throughout the distributing

mains very nearly constant; however, the distribution of the consumption may vary without requiring conductors of excessive size." He did not hesitate to say that in the year 1882, feeder conductors to arc lights in series not only was unheard of, but would have been an absurdity, feeding mains being required to take the energy to the various points where it was going to be distributed. Page 5, line 20, was the only reference to arc lighting: "When special circuits are required for specific purposes, as for charging secondary batteries or for arc lighting in addition to the ordinary incandescent lighting," &c. Reference was then made to the figures incorporated in the specification. The learned counsel said he hoped no electrician would come and say fig. 5 meant arc lighting in series. Anybody looking fairly at that drawing must come to the conclusion that a person was told to establish a system of incandescent lights. It was only for the purpose of trying to invalidate the patent that any such construction was sought to be imported into it. In conclusion, he asked his Lordship to say that it was proved to demonstration that the plaintiff's invention meant an improvement in incandescent lighting and nothing else, and that the fact that with the improved arc light you could take out incandescent lights and put in an arc light had nothing to do with it.

Sir HORACE DAVEY, Q.C., then opened the case for the defence He said he felt somewhat embarrassed, because he had been told by Sir Richard Webster that the argument he proposed to address to the court was one which no honest man could use, and Sir Richard Webster had implied, if he had not said, that it could only have been invented by some person who desired for a sinister purpose to read the specification in a way which would invalidate the patent. Further, Sir Richard said that he had been taken by surprise. That was a rhetorical artifice on which he (Sir Horace's) experience had taught him to place very little reliance. Sir Richard knew that the defendants intended to say what it now became the duty of their counsel to say—that whatever the patentee might have intended—whatever might be the most useful mode of employing the system he described in his specification, whatever might be the meaning he attached to certain words, from one end of the specification to the other you would not find one single word or phrase which pointed to this specification being confined either to incandescent lighting or lighting in parallel circuit. But more than that, it was apparent from the language which the patentee had used—and he was dealing with a patentee who was not only distinguished in the world of science, but knew the use of the English language as well as any man in that Court—that he intended to include within the net of his specification all lamps or electricity consuming appliances. The patentee had carefully told them that his invention was to be applicable to any system of electrical distribution or supply; he said, "I place two systems of lamps or other appliances consuming electricity." He (Sir Horace Davey) should submit that the language Dr. Hopkinson had used—advisedly or inadvisedly—was such as would enable him to sweep within his ambit the use of the three-wire system in connection with a system of lighting by series, and a system of lighting by arc lights as well as by incandescent lamps. If that were not so, what would have been easier for him (knowing there were these two systems) than to have said "I place two systems of lamps or other appliances consuming electricity in series in a parallel circuit?" If his learned friends were right in saying that the system was of no utility in connection with arc lighting or series lighting, what was to become of the patent, the patentee having expressed himself in such language as to include arc lighting or series lighting? It would be bad on that ground. He did not say it was, because he thought Dr. Hopkinson did intend it to include all applications of the three-wire system and that all applications of the three-wire system were useful, although he agreed that in parallel multiple bridge the most benefit was obtained. There was another way of presenting this case. Assuming that he proved that persons did in fact use the three-wire system in connection with arc lighting and arc lighting in series, and the poor creatures thought they derived a benefit from it, what was to prevent them substituting another perfectly well-known mode of lighting on the wires they had? They would require the aid of no patentee for that. Sir Frederick Bramwell said they would have to make some alterations in their wire. Be it so; but they would equally have to make these alterations in exchanging a single circuit system into a parallel system. How could Dr. Hopkinson, or anybody else, prevent them from doing that which they did not require the aid of his patent to do? The utmost he could have said would be, "I was the first person to point out the effect of applying the three-wire system"; and the reply would be "Your patent teaches us nothing as to the mode of doing what we require." If his learned friend's contention were right, Dr. Hopkinson would be telling people that they should not substitute a parallel incandescent system for their arc system in series because he had taken out a patent not telling them how to make the change but for the use of the three-wire system in parallel arrangement. That would be telling a person who already had the three-wire system what was the most beneficial way of using his system—nothing more—and the objection would be want of subject matter. There were two distinct inventions comprised in the plaintiff's patent; one was for regulating or indicating the difference of potential at a distant point along the mains, the other for reducing the cost of conductors for electric supply consistently with efficiency and safety. He denied that because at the time when this specification was drawn the instrument described could only properly be useful for measuring potential in connection with a parallel system of distribution that a parallel system of distribution only must therefore be understood by the words "conductors of electricity." A person might perfectly well describe and patent and claim an instrument for measuring potential which would be an extremely useful instrument for that time, but a person would use it for the purpose for which he wanted it. It might be that he would only want it for the purpose of measuring potential in arc lighting. Could it be supposed that if anybody used it for that purpose it would not be within the patent? Of course it would, because the claim was properly for the regulator, and not for the use of the regulator. His (Sir Horace's) next point was that in the words, "When electricity is delivered by means of a pair of conductors to a distance from the station where the electricity is generated, there is a fall of potential due to the resistance of such conductors," &c., to confine it to an electric supply based on the parallel arrangement. "To ascertain the potential at the far end of the conductor," referred to an instrument for measuring potential which might be used for systems other than the parallel, and was an arrangement with respect to which what was claimed was not the application but the instrument itself, apart from its application. With reference to the second part of Dr. Hopkinson's invention, the learned counsel said that at that time men's minds were only beginning to be directed to incandescent lighting; the system of lighting best known was arc lighting. If the patentee under these circumstances intended to tell people that he was going to give them a means of lighting by incandescent lamps in parallel, you would have expected him to say so in terms. But he carefully abstained from confining it to what it was now alleged to be confined to, and used language which, as it was understood on that side of the bar, not only comprised both systems of lighting, but other systems of electricity consuming appliances. It was a large order on their understanding to ask them to believe that "For the purpose of economising the cost of main conductors, I place two dynamo machines in series and I place two systems of lamps or other appliances consuming electricity of approximately equal capacity also in series;" was to be confined to lamps placed in parallel. But if that were to be so, he should be obliged to attack the patent on another ground, namely that it was so hopelessly ambiguous that you could not tell what it did mean.

At this stage the Court adjourned for the day.

(To be continued.)

NEW PATENTS—1892.

19,025. "Electricity meters and improvements therein." A. WRIGHT. Dated October 24th.

19,061. "Electric railway systems." W. E. IRISH. Dated October 24th. *(Complete.)*

19,062. "Improvements in means or apparatus for enabling electric current to be derived from an incandescent lamp holder and conducted to a lamp or other electric apparatus at a distance therefrom." S. A. HUNTER. Dated October 24th.

19,076. "Improvements in or relating to microphone carbons." G. S. HOOKER. Dated October 24th.

19,077. "Improvements in or connected with mains or conduits for electric cables." J. AIRD. Dated October 24th.

19,118. "An earth stocking for protecting telegraph and other poles." T. DODDRELL. Dated October 25th.

19,127. "Improvements in electric arc lamps." G. J. PHILPOTT. Dated October 25th.

19,146. "Improvements in insulators for electrical and other purposes." H. H. LAKE. (Communicated by Johns Pratt Company, United States.) Dated October 25th. *(Complete.)*

19,160. "Improvements in or connected with telephone receivers." W. P. THOMPSON. (Communicated by G. V. Benjamin, United States.) Dated October 25th. *(Complete.)*

19,170. "Improvements in the production of chlorine, soda, and other products by electrolysis, and in apparatus employed therein." H. BLACKMAN. Dated October 25th.

19,172. "Improvements in electrical apparatus for lighting and extinguishing gas lamps, and for indicating automatically whether the gas is lit or extinguished." A. ORLING. Dated October 25th. *(Complete.)*

19,184. "An improvement in incandescent electric lamps." O. IMRAY. (Communicated by the Westinghouse Electric and Manufacturing Company, United States.) Dated October 25th.

19,194. "Improvements in telephones and in the application thereof to railway signalling." C. L. DAVIES. Dated October 25th.

19,220. "Improvements in electric batteries." E. FREUND. (Communicated by E. Freund, Austria.) Dated October 26th.

19,222. "An improved apparatus for the production of electric currents, alternating in direction with great frequency." D. SALOMONS and L. PYKE. Dated October 26th.

19,236. "Improvements in and relating to the generation and distribution of electrical energy." G. WILKINSON. Dated October 26th.

19,242. "Improvements in cases for containing electric batteries and the like." A. OBLASSER and C. THEBYC. Dated October 26th. (Date applied for under Patents Act, 1883, Sec. 103, April 26th, 1892, being date of application in France.)

19,248. "Improvements in conduits for electrical conductors." C. E. WEBBER. Dated October 26th.

19,282. "An improvement in or connected with galvanic batteries." W. WALKER. Dated October 27th.

19,293. "Improvements in electric lock and alarm." R. BAUMANN. Dated October 27th. *(Complete.)*

19,303. "Improved means for transmitting telegraphic signals.

through submarine and like cables." E. H. DRAPER. Dated October 27th.

19,361. "An improved process of electroplating glass, china, &c." A. S. FORD. Dated October 28th.

19,385. "Improvements in or relating to the distribution of electrical energy and in maintaining the potential thereof." W. LOWRIE. Dated October 28th.

19,386. "Improvements in or relating to the supply of electrical energy for propelling or lighting purposes upon electrical railways." W. LOWRIE. Dated October 28th.

19,387. "Method of increasing the speed of signalling in submarine or subterranean cables, and the construction of such cables for this purpose." SIEMENS BROS. & Co., LIMITED. (Communicated by Messrs. Siemens & Halske, Germany.) Dated October 28th.

19,393. "Improvements in electric battery apparatus." T. FROGGATT. Dated October 28th.

19,404. "Improvements in or relating to safety cut-outs for electric generators, transformers, and motor generators coupled in parallel." J. S. RAWORTH. Dated October 28th.

19,451. "Improvements in voltaic batteries, electrodes, and connections." H. F. JOEL. Dated October 29th.

19,478. "Improvements in electrical apparatus for increasing the adhesion of the wheels of engines on railway rails." A. PALAZ and V. DUBOUX. Dated October 29th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

6,372. "Improvements in electric time calls." R. VARLEY, Jun. Dated April 14th. The inventor makes use of a time mechanism such as a clock, and connected with the same a circuit-closing device that revolves once in 24 hours, and as this circuit-closing device is moved, a spring upon the same comes into contact successively with circuit closing pins or buttons arranged at distances apart corresponding to quarter hours or other measures of time. An annunciator board is provided with as many pins as there are contacts in the circular range, and these are arranged regularly to represent hours, and quarter hours successively, and there are wires from these pins on the annunciator to the pins in the circular range of contacts. A bell, or similar electric alarm, is arranged in an electric circuit, and there are bars or branches of this circuit adjacent to the pins of the annunciator, and these pins of the annunciator are adapted to hold one or more circuit-closing checks, and these checks are to be numbered corresponding to the rooms where the call is to be given. 5 claims.

6,397. "Improvements in phonoporic telegraphy." C. LANGDON-DAVIES. Dated April 14th. Relates to a key that when it rises and leaves the battery contact stud it comes upon another contact stud, thereby closing a circuit through the core winding, but in such a manner that the vibrating circuit-closer ceases to be operative. 1 claim.

10,338. "A machine for separating magnetic iron sand from gold, titanium, and other foreign matter, for the purpose of obtaining these for use." W. C. ALEXANDER. Dated June 18th. A vessel containing iron sand, or iron sand, water, or other liquid, is made to revolve. A permanent or electro-magnet is then placed in it, on which collects the particles of magnetic iron, leaving the gold, titanium, and other matter behind. 1 claim.

12,982. "An electric automatic time check." F. G. M. WETHERFIELD. Dated July 31st. Consists of a small iron box mounted upon a wooden base in which is a drawer with a lock. This drawer is divided into two compartments, one for "Early" and the other for "Late" checks or tickets. These checks or tickets are dropped by the workmen or employees through a slot in the top of the box, and are in the case of "Early" or "In time" tickets deflected by a guide into the front division of drawer. In the inside of box there is an electro-magnet, in front of which an armature is hung eccentrically. This armature has one end chisel-shaped, and has a recess cut at back. This recess supports a rocking lever, on one end of which is riveted a plate at right angles, and on the other end is hinged a rod also at right angles. This rod has a plate with the words—"Late"—"Early"—engraved upon it, and terminates in a ball. When the armature is attracted by the magnet the rocking lever is liberated and the plate at its end assumes an angle across the box, and thus deflects the tickets into the "Late" compartment. At the same time the word "Late" appears through a slot cut in the front of box, and warns the hands that they are late. The withdrawal of the drawer automatically resets the mechanism for the next operation. This resetting is done automatically by a piece of brass attached to back of drawer, bent at an angle downwards. This, as the door is drawn out, slips under the ball on end of rod, and replaces the rocking lever on the recess of armature. The hour hand of the clock is fitted with a brush of fine copper wire which glides over contact points fixed to face of clock at the hours at which time is taken, and close the electric circuit, consisting of a battery, wires, clock, and an electro-magnet. 6 claims.

17,310. "Electric signalling apparatus for use with a network of electrical lines or conductors." L. VON ORTH and E. BRESLAUER. Dated October 10th. Relates to an arrangement of apparatus whereby one or more predetermined signals can be sent from any point of a network of electrical lines to a station electrically connected with this network. 3 claims.

CORRESPONDENCE.

An Instrument Wanted.

Referring to the note in your last issue under this heading, I beg to inform you that an instrument for measuring the intensity of disturbing and other sounds heard on telephone lines is already in existence. It is called the "phonometer" or "sound-comparer," was invented by Mr. Farnham, of the New England Telephone Company, Boston, and is manufactured by the Western Electric Company.

I should have much pleasure in showing one of these instruments to anyone interested.

J. E. Kingsbury,
Manager, The Western Electric Company.

November 8th, 1892.

Niagara.

Mr. Steavenson will pardon me if I first of all point out that I have not said that the engineers connected with the Niagara scheme are "more experienced" than he. I did not even say they are *as* experienced, but merely that they are experienced. Mr. Steavenson tells us that, after spending 40 years in sinking shafts in quicksand and blue basalt, he thinks "there never was the slightest difficulty about" the Niagara scheme, for "if the turbines don't realise all the work anticipated, there is abundance of water to fall back on." Surely he does not imply that if the turbines do not develop the power required, they may be assisted by letting more water into the wheel pits and the tunnel? Mr. Steavenson knows very well that if the present plant does not realise the guaranteed efficiency, the 100,000 horse-power can only be obtained by a capital outlay on *more engines and tunnels*. It is absurd to argue that because there is plenty of water in the river there is no need to trouble about whether the engines will or will not give a high efficiency. The reference to Edison is irrelevant, as Mr. Steavenson admits that that inventor was "consulted on the electrical features" of the Niagara scheme. What have this and the "little cheque" to do with the useful effect of turbines?

I am surprised that any engineer with 40 years hydraulic experience should deny an efficiency of 70 per cent. to turbines. There are, no doubt, turbines on the market in which it would be impossible to get this efficiency—cheap, nasty, cast-iron turbines, badly designed, and worse built. It is not to these I refer when I say that a high efficiency is obtainable, but to the first-class engines, some of which I have described in my papers. Has Mr. Steavenson tested a "Vortex," or a "Victor," or taken measurements on high falls with a Pelton wheel? He mentions having on two occasions failed to get a high efficiency, but does not state the names of the engines on which his tests were made. Mr. Steavenson rejects the evidence of the Holyoake tests, which, by-the-bye, have in most, if not all, cases been conducted by competent and disinterested engineers; but gives no reason for considering them unreliable. It would be interesting to learn his reason.

To an electrical engineer, the most practical test of efficiency lies in the number of lamps which can be fully incandesced with a given flow of water under a given head; and the writer could give scores of instances in which this practical mode of reckoning has shown a higher efficiency in the engine than 70 per cent. But Mr. Steavenson asks for brake measurements: let me give him one, out of many equally good. On a fall of 74 feet, a "Vortex" turbine was supplied with 900 cubic feet of water per minute, the engine running at normal speed in a brake. The theoretical H.P. was, of course, 126, and of this 98·5 H.P. was obtained at the brake, *giving a commercial efficiency of* 78·17 *per cent.* The water was supplied from a compensation reservoir. It were useless to multiply instances, since Mr. Steavenson's contention is that so high an efficiency is not attainable.

The two concluding sentences in Mr. Steavenson's letter are based on false political economy; moreover, the City and South London Railway *has* paid a dividend.

E. Tremlett Carter.

Brighton Lighting.

Your readers may probably have seen a recent leading article in the *Daily Telegraph* of November 2nd, referring to the differences that have arisen between the Brighton and Hove Electric Light Company and the Corporation of Brighton (copy enclosed). The chairman of this company, Mr. Robert Hammond, wrote a letter to the *Daily Telegraph*, which that paper did not publish. I venture, however, to send you a copy of this letter for publication, believing that the attitude of the Brighton Corporation towards this Company is one of great moment and of close interest to the members of the electrical industry.

Alfred A. Hodgson, *Manager.*

Brighton, *November 7th*, 1892.

[COPY.]

The Brighton and Hove Electric Light Company, Limited,
Offices and Works, Gloucester Road,
Brighton, *November 2nd*, 1892.

To the Editor *Daily Telegraph*.

Sir,—In one of the leading articles of your to-day's issue, you refer to the friction existing between the Brighton and Hove Electric Light Company, of which I am chairman, and the Corporation of Brighton. I feel certain that I may rely upon your known desire to set forth both sides of a question, to afford space for the following explanation of the electric lighting question at Brightoh.

I may remind your readers that, as an almost universal rule, whenever a corporation has determined to take into its own hands the supply of gas, water or electric lighting, it has taken over, at a valuation, the works of the private company that has hitheto had such supply in its hands. The only exception that has been made by any corporation in this country up to the present moment, has been made by the Corporation of Brighton, the exception being in connection with this very electric light supply to which you refer.

Now, Sir, I think I may say that, however politicians may differ as to the wisdom of corporation trading, they are all agreed upon the principle that when a corporation determines to engage in an industrial undertaking it should take over, on mutually equitable terms, the private concern already in existence, which has done the pioneering and established a goodwill.

Up to the present time, at all events, no one has proposed in the case of gas or water companies that corporations should start opposition works and squeeze out the existing concerns by the sheer force of opposition, and by a lavish expenditure of the ratepayers' money.

The Brighton Corporation, however, composed, strange to say, principally of tradesmen with very keen notions, individually, of the sacredness of private rights, hold, as a corporate body, exactly opposite views, and though the Brighton Electric Supply works, which my firm founded in 1881, has during the past 10 years fully coped with all demands for electric lighting in Brighton and Hove, the corporation of Brighton a year ago actually started opposition works, and refused to treat with the Brighton and Hove Electric Light Company on any terms whatever for the acquisition of its undertaking. No wonder that men conducting their business on these lines shut their eyes to the real interests of the town in other directions.

In your leading article you draw attention to the neglect of the Brighton Corporation to light the magnificent sea-frontage with the electric light, and you will doubtless be surprised to hear that the company (of which I am chairman) has made two offers to light the sea-frontage in Brighton, the last offer being dated March 6th, 1890. The offer being to charge the corporation for the lighting *the same price as gas*, both of which offers were declined with thanks.

You state in your article that the Brighton Electric Light Company is seeking to extend its area of lighting, but if you will grant me a little more of your space, I should like to lay before the public the exact facts, as making them public will, I am sure, tend to get justice for the enterprise which the Corporation of Brighton are trying to stamp out.

No application whatever is being made by the company to extend its area, for ever since 1881 the Brighton Electric Light Company has not confined the electric light supply to any particular portion of the town, but has run its wires in every direction, wherever the demand arose, the circuit at one time measuring 20 miles.

I may remark *en passant* that during all these years the corporation, which obtained Parliamentary powers as far back as 1883, neglected to do any work whatever, and left the company in possession of the field to work up the business.

The undertaking having been started at such an early period of the electric lighting industry, the engineers followed the then universal custom of placing the cables overhead, but in 1888, after being requested so to do by the Board of Trade, consequent on a report made by one of their inspectors, the company made application for a provisional order to place its cables underground. The corporation, however, not consenting to the granting of the order, the Board of Trade held a local enquiry in April, 1889. No evidence, whatever, it may be stated, was tendered by the corporation of their intention, within a reasonable time, to fulfil the obligations of their provisional order granted to them in 1883. On the contrary, the corporation opposed the grant of the order to the company upon the grounds that electric lighting was in an experimental stage, that no system was reliable, and that when such was discovered the corporation intended to supply the light themselves under the order which had been granted to them, and which, up to the date of the enquiry, and, indeed, till July, 1889, had been a dead letter.

The result of the enquiry was that the inspector reported in favour of an order being granted to the company for Brighton, but after the enquiry was closed, and when the company had not an opportunity of being heard or cross-examining, the corporation sent a deputation to the Board of Trade to assure the President of their intention to carry out the provisions of their order, and upon which representation the company was refused the order which they had been invited to apply for, and upon the faith of obtaining which they had spent a considerable amount of money in advertising the usual notices, engaging counsel and witnesses to appear at the local enquiry, and other professional assistance.

Upon the order being refused, the corporation, abandoning their contention that electric lighting was an experiment, advertised for tenders for works to supply the electric light to a small area of the town where the bulk of the company's consumers were situated. Tenders having been received, the corporation applied to the Local Government Board for sanction to borrow some £30,000, and an enquiry was held at Brighton in April, 1890, by the Local Government Board. At this enquiry the company appeared and stated their case. A petition, signed by nearly 10,000 ratepayers, was also presented by Mr. J. L. Wood in opposition to the scheme. A very strong minority of the corporation was also opposed to the sanction and expenditure of such a large sum of money in this direction, as it was pointed out, and proved to the inspector, that an advantageous offer had been made to the corporation by the company. The proposed expenditure by the corporation was, however, sanctioned, and the corporation works erected. The Town Council confidently expected that the opening of the works a year ago would result in the immediate ruin of the company, but, to the surprise of the corporation officials, the company has gallantly held its ground, beating the corporation at every point, and actually doubling its business during the past 12 months.

On the other hand, the company is able to say that since its applications, commencing in 1889, for provisional orders, the directors have made every endeavour, as originally suggested by the Board of Trade, to come to terms with the corporation. Last autumn (1891) they succeeded so far as to enter into a draft agreement with the lighting committee of the corporation for the purchase by the corporation of the goodwill and undertaking of the company, so far as it related to the supply and sale of the electric light within the borough. The draft agreement was submitted to the corporation by the lighting committee with a strong recommendation for its acceptance; but the corporation, although the majority of its members have admitted that the company have done the town a great service during the years they have been established, refused to sanction it, and only last Monday, to more effectually try to crush the company, the corporation have resolved to further extend their area, and to apply to the Local Government Board for a further loan.

This most recent move of the Brighton Corporation has doubtless been caused by the appearance of the statutory advertisement of the company, giving notice of its intention to again apply in the coming session to the Board of Trade for a provisional order.

I am sure that the public, with the facts before them, will join with me in the hope that the company's order may be granted, and that the Board of Trade will not, by refusing the order, assist a corporation, armed with statutory powers, and backed by practically unlimited credit, to work a gross injustice by destroying a trading company, already weakened by the heavy expense of supplying light through its experimental changes, and a company which has been of the greatest service to public and private consumers in the borough during a period of 10 years, and during a time when the corporation, though they possessed statutory rights to supply electricity, failed to put them in force.

I am, yours obediently,

Chairman Brighton and Hove
Electric Light Company, Limited.

The Meter for the Million.

Your article, "Wanted—A Meter for the Million," is rather startling, considering its source. In it you make the statement that no electricity meter has yet appeared which can compare with a gas meter in simplicity, reliability, cheapness, and perfect fitness for its work; and this statement must be challenged in its entirety,

The simplicity of the gas meter may be admitted freely, as well as its accompanying cheapness, but I dispute its reliability and perfect fitness for its work, from the following experience.

Some three years ago, I had occasion to complain of the record given by a gas meter, and it was officially tested and found erroneous—as against the consumer—to the extent of more than thirty per cent.; and other defective meters have come within my experience. The superintendent of the district informed me that a great many defective meters were known to the Gas Company, but they estimated that the balance was largely against them, as people seldom complained of meters which recorded against the company; and he informed me that a reliable gas meter was greatly wanted. Now, I will not assume that defective meters are divisable into those which record 30 per cent. too much, and 30 per cent. too little, but supposing the maximum error to be 30 per cent., can such a meter be considered reliable?

As to the perfect fitness for its work, we know that gas rapidly changes volume with every change of temperature, and that we are charged by volume. Is there any gas meter in general use in which temperature corrections are automatically made, and if so, is it a cheap and simple meter? Also, is there connected with any gas meter any device compensating for the difference in friction between high and low speeds. If these things are unknown to gas meters—while insisted upon by the Board of Trade, for electric meters—is it fair to make the comparison you do?

Considering how long gas has been in general use, and how short a time electric meters, it is amazing that the latter are as good as they are; especially, as dealing with a practically unknown force. There are many very fair meters at work—complex though they may be—and you would do good service, I believe, in obtaining results from the authorities of the testing of both gas and electric meters, and publishing the curves of their performances.

J. Sinclair Fairfax.

November 2nd, 1892.

Dry Cells, Electrical Formulæ, &c.

Could you oblige me through the medium of your valued paper with the composition of any of the dry cells now in use, are they as cheap and durable as the ordinary cells, and can they be used for the same work as the common cells, and do they give the same satisfaction?

If you, or any of your readers, could favour me with a solution of the following question, and the formula applicable in such cases I would feel greatly obliged:

"A piece of wire, 20 feet long and 10 mils in diameter, is found to have double the resistance of another wire of the same metal 15 feet long and of unknown diameter. What is the diameter of the second wire?"

Would you also kindly say where a description of the "absolute" and "sensitive" galvanometers is to be found, or if they are known by any other name.

Voltaic.

[The first question we would prefer to leave to some of our readers.

The wire problem may be worked out in the following way:—Let the resistance of the 15-foot wire be, say, 15 ohms, then the resistance of the 20-foot wire would be 30 ohms (since it has, as stated in the question, twice the resistance of the 15-foot length). But if the length of the 15-foot wire were 20 instead of 15 feet, then its resistance would be 20 ohms; hence, since the resistances of equal lengths of wires are inversely as the *squares* of their diameters, we have the inverse proportion:—

$$20 : 30 :: 10^2 : x^2,$$

or

$$x^2 = \frac{30 \times 10 \times 10}{20} = 155,$$

that is

$$x = \sqrt{155} = 12{\cdot}45.$$

A "sensitive" galvanometer is one whose needle, when deflected by a current, changes that deflection perceptibly and quickly when the current causing the deflection is either increased or decreased very slightly; if the needle does not move when the change of current takes place the galvanometer is said to be "insensitive" or "sluggish." An explanation of the meaning of an "absolute" galvanometer may be found in Ayrton's "Practical Electricity," or Silvanus Thompson's "Electricity and Magnetism."—EDS. ELEC. REV.]

The Institution of Electrical Engineers.

The Institution of Electrical Engineers is the principal corporate representative of an important and increasing profession. In its early days, and especially when it existed as the Society of Telegraph Engineers, it was the principal exponent of the scientific aspect of electrical progress and attracted a large number of gentlemen only indirectly connected with practical engineering.

Under those conditions it was appropriate that the council should have been composed to some considerable extent of professors and similar representatives of purely scientific effort.

The council, which has the responsibility of nominating its own members, has always given due, if not excessive, prominence to this idea, with the result that at the present time, notwithstanding that the membership now includes a very large number (in fact a considerable majority) of electrical engineers actually engaged on important works; that body consists of:—

10 Actual or nominal professors.
4 Physicists.
11 Present or past representatives of Government departments, including naval and military officers.
7 Electricians and electrical engineers.

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Or omitting the Vice and Past-Presidents it consists of:—

5 Actual or nominal professors.
7 Present or past representatives of Government departments, including naval and military officers.
3 Electricians and electrical engineers.

15

From a consideration of the above list, which the most vivid imagination would have difficulty in recognising as being representative of the present membership of the Institution of Electrical Engineers, we turn with relief to the Institute of *Civil* Engineers, an association which has earned the respect not only of this but of all civilised countries, and whose principles and procedure may with advantage be imitated by other societies aiming at similar objects.

Their council is composed almost exclusively of engineers in actual practice; it contains only six representatives of Government departments, and no professors.

It must not be considered from the above remarks that any professor who sits on the council of the Institution of Electrical Engineers is not in every respect an ornament to that council, and that his presence there does not give satisfaction to the whole body of members and associates, for we fully believe that the contrary is the fact.

In approaching this question, we wish to deal exclusively with numbers, and we have neither intention nor desire to approach the subject from the point of view of the personal or contingent qualifications of individuals, for notwithstanding that we, in company with other members, entertain a high personal regard for each and every member of council, we feel that it is imperative in the interest of the Institution that that body should be truly representative, no class or interest predominating over others.

We have accidentally commenced with the professional element, but there can be no doubt also that the various departments of Her Majesty's Government have at the present time a representation much in excess of their share in general electrical work, and that some of the seats held by both the above-mentioned classes might, with advantage, be distributed amongst other branches of the profession.

We know that our views, as expressed above, are shared by a large and influential section of the Institute, and we believe also by some members of council, who would have given effect to them had they been supported by any general expression of opinion.

We do not advocate, as politic or possible, the making of any immediate radical change in the constitution of the council, but we do advocate a gradual modification of it, by the nomination on the part of the council of new members actively employed in constructive work to replace others retiring in rotation, until a more equal balance be attained.

As the date of the annual election is approaching, we have taken the liberty of bringing this subject forward through the medium of the Press, in order that an opportunity may be afforded to members of the Institute of expressing their opinion on a subject which we are assured is attracting serious and increasing attention.

R. S. Erskine.
Manville.
Alfred E. Mavor.
John S. Raworth.
A. A. C. Swinton.

November 7th, 1892.